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Central cities in regional development

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CENTRAL CITIES IN REGIONAL DEVELOPMENT

by

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I. INTRODUCTION

It is a curious paradox that while Iowa's economy remains agriculturally based, the proportion of the population directly engaged in farming is rapidly becoming only a small fraction of total population. This phenomenon is not peculiar to Iowa nor is it new and startling.

The decline in the number of farm people in any agriculturally-based area is geographically widespread. The problems which have resulted from this transition are complex and numerous. Much has been written about the so-called "farm problem". The implications of the situation, however, point to an analysis directed, not specifically at the agricultural sector, but rather toward the economic region as a whole. The basic consideration is with reference to the maintenance of growth and the stimulation of development, in terms of per capita income, within such agriculturally based economic areas.

What do we mean by an economic area? The concept of a region which transcends local governmental units, was discussed by Dickinson (21) in 1947. He suggests that such an idea was presented as early as 1898 by a Frenchman, P. Foncin. Karl Fox has coined the phrase "functional economic area" (FEA) (31, p. 20). Fox defines an FEA as a geographic region in which ... "almost all the labor resident in the area is sold within it and almost all the goods consumed in the area are bought within it" (34, p. 6). Usually such a region has an area of 4,000 to 6,000 square miles surrounding a focal point which we shall refer to as the "central city". Theoretically, any point within the

the region is also within an hour's travel time of the central city.

It is the role which this central city -- the node of economic activity -- plays with respect to the economic well-being of the region that will be the focus of our analysis. The term "central city" has been used in at least two contexts. Vernon's (84) use of the term is equivalent to "center of the city". Our use of the term will refer not to a part of the city, but to a whole city roughly centrally located within a region. This distinction is important. We are concerned with the relationship of the entire urban complex to other towns within the region and to the region as a whole.

The size of the nodal or central city varies. According to Fox, the population of the central city may range from less than 50,000 to more than 300,000 (34, p. 6). Most central cities fit Philbrick's (67) fourth-order central place classification, although a few may be only third-order places. More will be said about the order of a town in Chapter II.

A. The Problem

Economic growth in dominantly agricultural areas is localized in the larger cities, which serve as central places in a system of trade centers and service areas (11, 15, 24, 31, 36, 37, 42, 43, 52, 62, 64, 80, 81). If we view central cities in regional development as growth nodes, the problem becomes much clearer. These central places serve as focal points for industrial development activities. Accordingly, information is needed that shows:

(1) The function of central places in long-run area growth; and

(2) The area development processes that account for differential rates of change in population, income, employment and purchase patterns within dominantly agricultural areas.

These needs suggest an information theory approach to regional analysis (24). The direction which planning and policy, both public and private, will follow for any region striving for development and growth is a function of available information. The effectiveness of such decisions depends upon the detail and accuracy of the information as well as the way in which it is used.

B. The Purpose

Having defined a functional economic area, central city, and the problem of their interrelationship, we may now state the objectives toward which this study is directed. Its purposes are three-fold.

First, we wish to identify elements of research strategy and to generate information for regional development planning. In other words, the initial objective is to select certain analytical techniques which will constitute an efficient methodology for regional investigation.

Having selected these elements of research design, it is then necessary to develop and evaluate their application in generating information for development policy. This is the second purpose of the study. We wish to determine which analytical tools best serve the information needs of a substate regional economy of the approximate size we have described.

The final goal of this analysis is to estimate certain structural relationships and to organize this system of relationships and variables into a comprehensive model of regional development with major emphasis on the central city as a regional "growth center". This means looking at the functional economic area within a general systems theory framework.

In summary, the purpose of this analysis is to select appropriate methodology, to generate information, and to draw policy implications for a functional economic system. The key element is, of course, information. What information is relevant? How should information be ranked in terms of priority for regional development planning? What information can be generated? How can it be generated most economically? What procedure should be followed?

C. The Procedure

The variable which will serve as a basis for the entire investigation either directly or indirectly is population. There are several reasons for this choice. Spengler points to the significance of population movement in economic growth and development because population change and economic change interact. Population is a cause, an effect, and an indicator of the behavior of phenomena connected with economic development (74, p. 249). Another reason for centering the analysis upon population is the readily available census data on detailed characteristics of population, such as age composition, employment, births, deaths and related variables. Finally, there are a number of analytical techniques that have been developed which provide economical means for analyzing the activity of an area from a population-composition approach. These techniques are economical both in terms of time and money required for regional analysis. Other more elaborate techniques are available, such as input-output analysis or a regional accounts approach, which might provide more sophisticated results, but whether or not the increased accuracy is worth the price of additional time and money is problematic. Our approach will enable us to investigate past and present trends, to project future tendencies, and to draw some policy implications.

1. Economic formulation

The economic analysis will be divided into three aspects, namely, population *per se*, employment, and consumption. Employment and consumption are, of course, a function of population. It is logical to conceive of human resources in terms of the characteristics of the labor force or in terms of consuming households. We may, therefore, view the economy in terms of both the supply and the demand factors affecting population growth.

Central place theory, first formulated by Walter Christaller (10, p. 108), will serve as the framework for the basic population study in chapter III. We will look at the central city within a system of cities giving special attention to the incorporated place system of Iowa. The six-county area around Fort Dodge, Iowa, has been selected for more detailed analysis. This area includes the counties of Calhoun, Hamilton, Humboldt, Pocahontas, Webster and Wright. It was selected because it represents a "typical" agriculturally-based economic area. By "typical" we do not wish to imply a specific type of farming (i.e., cash grain, dairy, etc.), but rather that the Fort Dodge area is representative of a region with an agricultural economic base. Implications drawn from this area should have considerable value for development planning in similar areas.

In chapter IV employment data from the Fort Dodge area, or "Sixco" as it has been called (43), will be used to ascertain economic change. For this purpose shift analysis and a basic-service industry ratio will be employed. Some consideration will be given in chapter V to spatial distributions which influence employment. Commuting patterns play a major role in determining the labor force of any area. The same may be said of migration, though migration also has more implications for consumption and consumption patterns. This leads the analysis toward an investigation of the trading patterns of Iowa farm families and open-country non-farm residents. The spatial aspects of this consideration will be discussed in chapter V while the implication of such trade patterns for trade center functions will be treated in chapter VI.

An attempt will be made in chapter VI to synthesize the information which has been generated into a comprehensive model for a regional economic system. Major emphasis will be on the information which the model provides concerning the role of the central city.

In chapters VII and VIII we will look briefly at the implication this study has for state development planning and attempt to draw some conclusions.

2. Statistical formulation

The statistical data used in this study are of two types, time series and cross-sectional. The time series data are taken from the U. S. Census. The cross-sectional data come from a 1960 "Business Impact" survey which was concerned with the trading patterns of 497 Iowa farms, 486 farm households, and 115 open-country non-farm households.

The subject matter which we have attacked is enormous. To expect completely adequate coverage of the topic within the limits imposed by time and money constraints is, of course, unrealistic. For example, we might consider the question of area delineation. Fox has suggested that the FEA's in Iowa take the shape of a diamond because of the nature of the road grid (30, 34). This idea warrants a good deal of consideration. Yet, we were forced to define the Fort Dodge area in terms of counties because the data were available only on a county basis. Given adequate resources to gather data from a diamond-shaped region around Fort Dodge, a very interesting comparative study might be conducted. If our study serves to scratch the surface of the problem, to generate some ideas or to raise some questions, then it has served its purpose.

II. ANALYTICAL FRAMEWORK

There is a chaos that arises from doubts and despair, a parasite upon order when it reminds us of the temporal nature of all human ordering, even though occasionally it may fructify order. But there is another sort of chaos, which is really nothing but order in disguise. Thus, the bewildering individuality of various places and events in space may arise merely because each consists of a special combination of different orders -- geographical, geological, political, racial, religious, and so on -- which interfere with one another and cause tensions but do not destroy each other's roots. The economic sphere is simply added to the many other spheres of life that overlap, neither dominating nor merely tolerating.

-- August Lösch (50, p.220)

A. Systems Theory

It is this order disguised in chaos, of which Lösch speaks, that has lead to the development of the methodology known as general systems theory. Systems analysis, according to Boulding (18) relies upon order and true analogy. It is a point of view rather than a body of knowledge. "A system is a device, procedure, or scheme which behaves according to some description, its function being to operate on information and/or energy and/or matter in a time reference to yield information and/or energy and/or matter" (27, p. 3).

How can a general systems approach be adapted to serve our purposes in analyzing the role of the central cities in regional development? Certainly, we might look at a region as an economic system, an organism -- not merely an organ (50, p. 219). A region has all the specifications of a system: inputs, outputs, states and behavioral relationships. Yet, for our population approach a more realistic answer lies within the framework of central place theory.

Since its initial formulation by Walter Christaller, central place theory has been subjected to considerable generalization, modification and extension, first by Lösch (50) and more recently by Berry (5,6), Berry and Garrison (9), Berry and Barnum (7), Philbrick (67) and others. The core of central place theory is the notion of a hierarchy of central places. A central place is defined as a city or town "performing retail and service functions for surrounding areas (5, p. 121)". The trade area, which a central place serves, is assumed to vary with city size. The purpose of the theory is to explain the size, number and distribution of towns. Berry (6, p. 122) has presented a model of the theory using structural equations and implications verified in several studies. We reproduce the model here because of the concise manner in which it presents the theory and because it should lend some insight into the approach which we will follow throughout the empirical analysis.

1. <u>The Model</u>

<u>Definitions</u>

P_t = the total population served by a central place

P_c = population of the central place

P_r = rural population and population of lower level centers served by the central place

A = area of the trade area

Q_t = population density of the area served

Q_r = population density of those parts of the area served lying outside the central place

T = number of central functions performed by the center, and since central functions enter in a regular progression and can be ranked from 1...T in decreasing order of ubiquity, also the highest level central function performed by the center

E = number of establishments providing the T types of business

D_m = maximum distance consumers will travel to a central place of size T, or the range of good T

q, k, a_i, b_i, w, s, x, m = constants

Identities First, by definition, we have,

$$P_t = P_c + P_r, \tag{1}$$

$$P_t = A\ Q_t, \tag{2}$$

$$P_r = A\ Q_r, \tag{3}$$

$$A = k\ D_m^q\ . \tag{4}$$

Structural equations In addition, a series of behavorial relations are given of the form,

$$\log P_c = a_1 + b_1\ T, \tag{5}$$

$$\log D_m = a_2 + b_2\ T, \tag{6}$$

$$\log E = a_3 + b_3 \log P_t\ . \tag{7}$$

These behavorial equations hold for any level of density and, hence, they define the relevant economic structures.

Implications The preceding equations can be combined in the form,

$$P_c = P_t^s w^{-s} Q_t^{-s} , \qquad (8)$$

where $\quad w = k \left\{ \log^{-1} \left[q b_1^{-1} (a_2 - a_1 b) \right] \right\},$

and $\quad s = (b_1)/(qb_2)$.

Further, the population of the central place increases exponentially as total trade area population increases while varying inversely with density, i.e.,

$$A = w P_c^x , \qquad (9)$$

where $\quad x = s^{-1}$.

As the population of the central place increases, the trade area served increases exponentially, i.e.,

$$E = m Q_t^{b3} P_c^{b_3} , \qquad (10)$$

where $\log m = a_3 + b_3 \log w$.

The number of establishments within a central place is an increasing exponential function of the population of the center and total population density.

<u>Definitional inequalities</u> Finally, a series of inequalities are given by the forms,

$$\log A_{tv} < 10.4 - 2.67 \log P_t , \qquad (11)$$

$$\log A_{tt} < 9.3 - 2.07 \log P_t , \qquad (12)$$

$$\log A_{tc} < 22.25 - 4.75 \log P_t . \qquad (13)$$

These three inequalities establish limits on the size of trade areas for villages, towns and cities respectively.[1]

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[1] A more detailed discussion of the model also appears in Berry and Barnum (7).

2. A hierarchy of nested functions

In his discussion of the systems model Berry divided central places into a broad three-fold classification of village, town and city. This division was adequate for his approach; however, for the purposes of this study we prefer to adopt a more detailed and functional grouping defined by Philbrick (67)[2]. This classification is seven-fold. Central places are ordered according to function. The first-order central place is defined as the household unit; its function is consumption. The distinctive function of the second-order place is retailing; the third-order, wholesaling; the fourth-order, transhipment; the fifth-order, exchange; the sixth-order, control; and the seventh-order, leadership. Each central place, besides performing the function which classifies it, also performs the functions of central places of lower order. Thus, classification forms a hierarchical network or system of central places.

By now the reason for selecting this particular classification should be apparent. Because it considers households as first-order central places, it provides a complete population system for any region. It provides a behavioral systems framework with population *per se* as the input and final consumption as the output, while locational considerations define the states.

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[2] A concise summary of Philbrick's classification appears in Isard (45, p.222).

In chapter I we concluded that our basic need was information. How does information theory fit into a systems framework? By definition a system operates "... on information and/or energy and/or matter in a time reference to yield information and/or energy and/or matter," (27, p. 3). General systems theory or cybernetics, as it is sometime called, incorporates information theory into its very foundation (5, p. 129; 23, p. 586). A general systems approach may encompass many specific theories such as the theory of linear systems, the theory of Markov systems, etc. (55, p. 4). This ability to encompass specific techniques within a flexible general framework is the quality which makes cybernetics a highly-useful approach. Its adaptability to almost any existing situation is noteworthy. Indeed, "... if politics is 'the art of the possible' in a system, cybernetics is the science of the actual (4, p. 11)".

We turn now to a discussion of the specific techniques which will be employed in our empirical analysis. In each case we shall look briefly at (1) the theory behind the technique, (2) the simplifying assumptions necessary for model construction, (3) the variables and relationships involved, and (4) the data requirements.

B. Pareto Functions and Markov Processes

Two techniques have been employed to facilitate analysis of size distribution of towns within a region. The first of these is the Pareto function or rank-size rule. It is based on the type of relationship known as Pareto's "law" of income distribution which states that

$$Ny^{a} = A, \tag{14}$$

where N represents the number of persons with an income of at least y. A and a are constants (89, p. 346). The function is represented graphically with logarithmic coordinates in figure 1. The slope of the function is -a and the vertical intercept is log A.

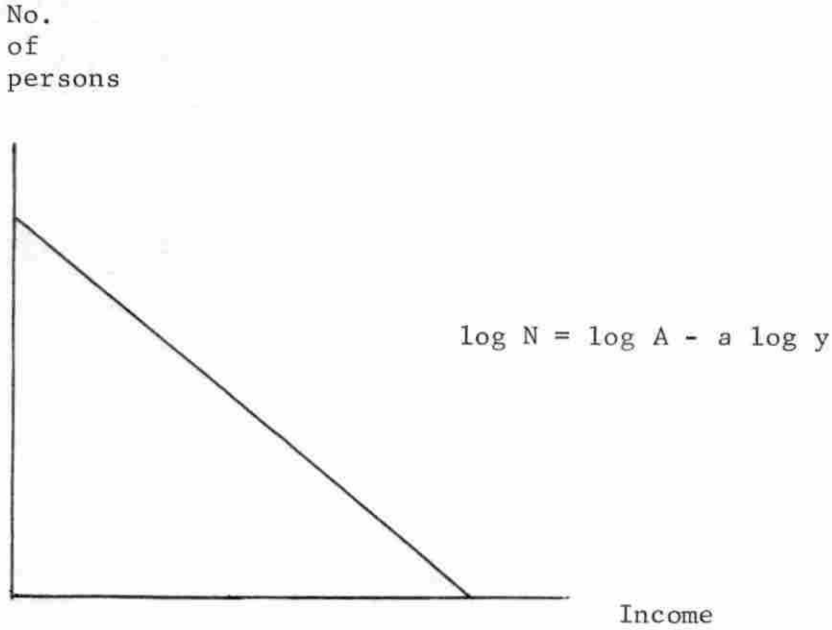

Figure 1. Pareto's "law" of income distribution

The rank-size rule is analagous to this "law". It states that

$$Y = BP^{-q}, \tag{15}$$

or,

$$YP^{q} = B, \tag{15a}$$

where Y is the number of towns with a population of P or greater and B and q are constants (5, p. 118). If $q = 1$ then B is the population of the first ranking town and P is the population of the city of rank Y, for all Y 1. The rank-size rule then says that neither the rank nor the size of a town is independent of the size of the largest city in a region (57, p. 238).

It can be shown that the statistical regularities of the rank-size rule are consistent with a hierarchical system of cities (3). We wish to show that, given a central place model such as Berry's, the rank of a city times its size equals a constant. The assumptions and variables used are basically those of the Berry model, unless otherwise stated.

Assumption 1: The population of a given city is a proportion K of the population of the trade area it serves, i.e.,

$$P_{c_i} = KP_{t_i} . \tag{16}$$

Assumption 2: Each city of a given order is surrounded by z towns of the next lower order within its trade area, i.e.,

$$P_{t_i} = P_{c_i} + zP_{t_{(i-1)}} . \tag{17}$$

Identity: $$P_{c_i} = K(R + P_{c_i}) \Rightarrow P_{c_i} = \left(\frac{K}{1-K} \right)R,$$

where R is the population of the rural area served by the 1st order of cities.

To solve, substitute Equation 16 into Equation 17,

$$P_{t_i} = KP_{t_i} + zP_{t_{(i-1)}} = P_{t_i} = \frac{z}{1 - K} \quad P_{t_{(i-1)}} \ ,$$

$$= \left(\frac{z}{1 - K} \right)^2 P_{t_{(i-2)}} = \ldots = \left(\frac{z}{1 - K} \right)^{(i-1)} P_{t_1} \ .$$

But, $P_{t_1} = R + P_{c_1} = R + \left(\frac{K}{1 - K} \right) R = \frac{R}{1 - K}$;

hence, $$P_{t_i} = \frac{z^{(i-1)}R}{(1 - K)^i} \ , \tag{18}$$

and, $$P_{c_i} = \frac{Kz^{(i-1)}R}{(1 - K)^i} \ . \tag{19}$$

If i assumes its maximum value N, then[3],

$$P_{t_n} = \frac{z^{N-1}R}{(1 - K)^N} \ . \tag{20}$$

Because of the assumption of an equal number of "satellite" cities of the next lower order for any city, the total number of cities, Y_t, in a given region, may be determined by,

$$Y_t = 1 + z + z^2 + \ldots + z^N = \frac{z^{N + 1} - 1}{z - 1} \ . \tag{21}$$

In other words, there is one city of order N, z cities of order N-1, etc.

If we assume that a specific order corresponds to a specific size class (e.g. Nth order city represents the 1st size class) then

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[3]For the Philbrick model N = 7.

the 1st town in the nth size class would have a rank,

$$Y = 1 + z + \ldots + z^{n-1} + 1 = \frac{z^n - 1}{z - 1} + 1, \tag{22}$$

within the system of cities. A city at the midpoint of the nth size class would have a rank,

$$Y = \frac{z^{n-1}}{z - 1} + \frac{z^n}{2} = z^n\left(\frac{1}{2} + \frac{1}{z - 1} \right) \quad . \tag{23}$$

By Equation 19 its size is,

$$P_{c_{N-n}} = \frac{KR}{z}\left(\frac{z}{1 - K} \right)N-n \tag{24}$$

Multiplying rank times size,

$$YP_{c_{N-n}} = \left(\frac{1}{2} + \frac{1}{z - 1} \right) \frac{KR}{z} \quad \left(\frac{z}{1 - K} \right)^N (1 + K)^n , \tag{25}$$

$$= C(1 - K)^n \quad ,$$

where C is a constant. Now,

$$(1 - K)^n = \frac{1}{(1 - K)^{-n}} \Rightarrow (1 - K)^{-n} = \frac{1}{(1 - K)^n} \quad ,$$

but, $$\frac{1}{(1 - K)^n} = (1 + K + K^2 + K^3 + \ldots)^n \quad .$$

Relative to 1, K is small, therefore,

$$(1 - K)^{-n} = 1 + Kn, \tag{26}$$

which is very nearly constant (i.e., its variance is small). The same is then true for $(1 - K)^n$; therefore, we have shown that the product of rank and size is constant. This implies that the empirical rank-size rule is consistant with central place theory.

The data requirement for the Pareto rank-size function is simply an ordered listing of towns within a region according to their population.

The second analytical technique used for the analysis of city size distribution is a Markov procedure. "Conceptually, a Markov process is the probabilistic analogue of the process of classical mechanics where the future development is completely determined by the present state and is independent of the way in which the present state has developed (29, p. 369)".

The assumption necessary in adapting this procedure to the projection of town size distribution is that the transition of towns among size classes between decennial censuses may be predicted by a probability distribution based on the transitions between classes during the previous decade. The model which defines this transition is,

$$(P_{ij})_t = (N_{ij})_{(t - 10)} / (T_i)_{(t - 20)} , \qquad (27)$$

where $(P_{ij})_t$ is the probability that a town which was in the ith size class at time (t - 10) will be in the jth class at time t. $(N_{ij})_{(t - 10)}$ is the total number of towns which were in the ith size class at time (t - 20) and in the jth class at time (t - 10), and $(T_i)_{(t - 20)}$ is the total number of towns in the ith size class at time (t - 20).

To perform the necessary calculation one must know the transition and distribution which took place within a given size class during the 10 year period prior to the most recent census.

C. Economic Base and Shift Analysis

There is a widespread consensus that the key to a region's growth and development is the expansion of the basic or export sector (17, 28, 45, 62, 65, 68). This view underlies economic base theory; it is extensively used in regional analysis despite several technical and conceptual difficulties and criticisms (53, 45). Briefly, it is a technique for analyzing intersectoral relationships and the impulses transmitted through an area economy by a change in the basic sector. The usual data utilized in this approach are employment figures for specific industries.

The theory encompasses the concept of a basic-service ratio and an area employment multiplier. The basic-service ratio may be represented by the equation,

$$R = \frac{B}{S} \ , \tag{28}$$

where B is total basic employment and S is total service employment. The regional employment multiplier is total area employment divided by total basic employment, or,

$$M = T/B \ , \tag{29}$$

where T is total employment. In using this approach we are assuming that employment ratios provide key information concerning economic change and development within a region. Economic base theory may be used as a basis for an analytical or a projective technique.

Shift analysis is a second approach for analysing economic activity and change within a region. It is a relatively new and simple technique which operates on much the same data and assumptions as economic base analysis. Detailed presentations of shift analysis technique may be found in Dunn (26), Perloff et al. (65), and Maki and Suttor (53).

This technique provides for the division of changes in employment in a given industry into three factors; the national growth effect the regional-share effect and the industry-mix effect. "National growth is expressed as the percentage increase in total employment. Industry-mix is given by the percentage distribution of employment according to industry. The regional-share component expresses the competitive position of a particular industry as shown by the percentage change in its employment (53, p.6)". The national growth element is the same for all industries while the "shift coefficients" for industry-mix and regional-share vary with the industries. The concept is expressed by the form,

$$\frac{\Delta e_i}{e_{it}} = \frac{\Delta E.}{E.t} + \left(\frac{\Delta E_i}{E_{it}} - \frac{\Delta E.}{E.t}\right) + \left(\frac{\Delta e_i}{e_{it}} - \frac{\Delta E_i}{E_{it}}\right), \qquad (30)$$

where,

Δe_i = change in regional employment in the ith industry from base year to terminal year;

e_{it} = regional employment in the ith industry in the base year, t;

ΔE_i = change in U. S. employment in the ith industry from base year to terminal year;

E_{it} = U. S. employment in the ith industry in the base year, t;

$\Delta E.$ = change in total U.S. employment from base year to terminal year; and

$E.t$ = total U.S. employment in the base year; t.

The national growth effect is $\frac{\Delta E}{E.t}$. The industry mix effect is $(\frac{\Delta E_i}{E_{it}} - \frac{\Delta E.}{E.t})$. The regional share effect is $(\frac{\Delta e_i}{e_{it}} - \frac{\Delta E_i}{E_{it}})$ (53, p. 38).

D. Commutation and Migration Patterns

The next major link in the analytical framework for investigating the population system involves spatial considerations. The first assumption is that commuting patterns tend to show, not only the labor supply area, but also the economic health of a city. The size of the commuting area also has implications for industrial growth and expansion. The technique used to analyse these patterns is one used by Fox and Kumar (34). Home-to-work commuting patterns are represented on a map of an area by arrows whose width is proportional to the number of people living in a township who work in a county other than the county where the township is located. The length of the arrows are proportional to the highway distance traveled to work. In the case of a township containing commutors to several counties the direction of the arrow was determined by the vector sum of the real or basic vectors.

An additional spatial consideration, which we assume affects the size and location of the labor force and, hence, economic activity is migration. The migration figures are derived by using a residual method (45, p. 54). The model used is,

$$M_w = (P_{t+w} - P_t) - N_w, \qquad (31)$$

where M_w is net migration during time period w, P_{t+w} is total population of the area in year t+w, P_t is total population of the area in year t and N_w is net natural increase during period w.

Data for this section of the analysis includes intercounty commuting information, birth and death figures and area population totals.

E. Consumer Preference Structure

Closely akin to spatial considerations is the analysis of final consumption and consumer purchase patterns. Here we assume that some indication of the intensity and effective location of final demand can be obtained from an investigation of such purchase patterns. Four techniques are employed in an attempt to discover the relative importance of town size and distance on the purchases of open country residence.[4]

The first technique assumes town size has no effect on purchase patterns. The second approach assumes that purchases are proportional to city population. In both cases a comparison is made between the expected percentage of purchases in a town of a given size with actual survey data.

The third technique compares mean distances traveled to towns of various sizes with expected mean distance under the two previous assumptions. The final approach involves a comparison of mean distances under the assumption that mean distance traveled increases with town size.

We have now outlined the basic analytical methodology which will be used in the following three chapters.

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[4]These techniques are analogous to the gravity model discussed in Isard (45).

III. CENTRAL CITIES IN A SYSTEM OF INCORPORATED PLACES

We look, first, at population characteristics giving major attention to the population of cities and towns. We are concerned primarily with the role of central population. Moreover, farm population is a relatively small proportion of the total. This does not mean, however, that farm purchases are unimportant. In fact, farm consumption and purchase patterns receive our primary attention in the study of the spatial distribution of local demand in chapter V.

The present chapter is divided into two parts. The first part considers the population distribution and system of cities for Iowa, as a whole. An operational analytical technique is presented for this purpose. In the second section, the system of cities in the six county area is examined.

A. Iowa Analysis

Iowa is divided into 15 economic areas. These areas are identified primarily on the basis of map examination, namely, road distance relationships of satellite towns and villages to the major city in their vicinity. Some counties that cannot be assigned on this basis are grouped with a particular economic area on the basis of newspaper readership and traffic volume patterns linking them. Only entire counties are involved in the delineation procedure because of data limitations.

Up to this point we have implied that the focal center of a region is a single city. Usually this is true; however, in some regions the focal center or "central city" is a complex of cities. Four such complexes exist in Iowa: the Waterloo-Cedar Falls-Evansdale complex; the Cedar Rapids-Marion complex; the Des Moines-West Des Moines-Urbandale complex; and the Davenport-Bettendorf complex. For our analysis, these groups of cities are treated as a single "central city".

Figure 2 is a map of Iowa showing the 15 FEA's and their focal centers. Figure 3 shows Iowa "urban places".[1] The area of the circle representing each town is proportional to its 1960 population. The shaded counties represent "standard metropolitan statistical areas" (SMSA).[2] Seven of the 15 areas have their focal point in SMSA. The population of the central cities in 1960 (83) ranges from 6,435 for Decorah to 226,752 for Des Moines.

Figure 4 shows the percentage of the total population living in urban places. According to the 1960 estimates, over 50 percent of total county population is located in urban places in 20 Iowa counties. Of these 20, 12 are the counties of area focal centers. The three central city counties not having over 50 percent urban population are Clay, Carroll, and Winneshiek. In all three cases the area focal center located in these counties had a population of less than 10,000. This is readily seen in Figure 5 which shows the proportion of urban population living in cities of 10,000 or more. The three specified areas have no such towns of 10,000 or more population.

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[1]The 1960 United States Census of Population (83) defines an urban place as a place of 2,500 or more inhabitants, either incorporated or unincorporated.

[2]The 1960 United States Census of Population defines a standard metropolitan statistical area (SMSA) as "a county or group of contiguous counties which contains at least one city of 50,000 inhabitants or more or 'twin cities' with a combined population of at least 50,000 (83, p. X).

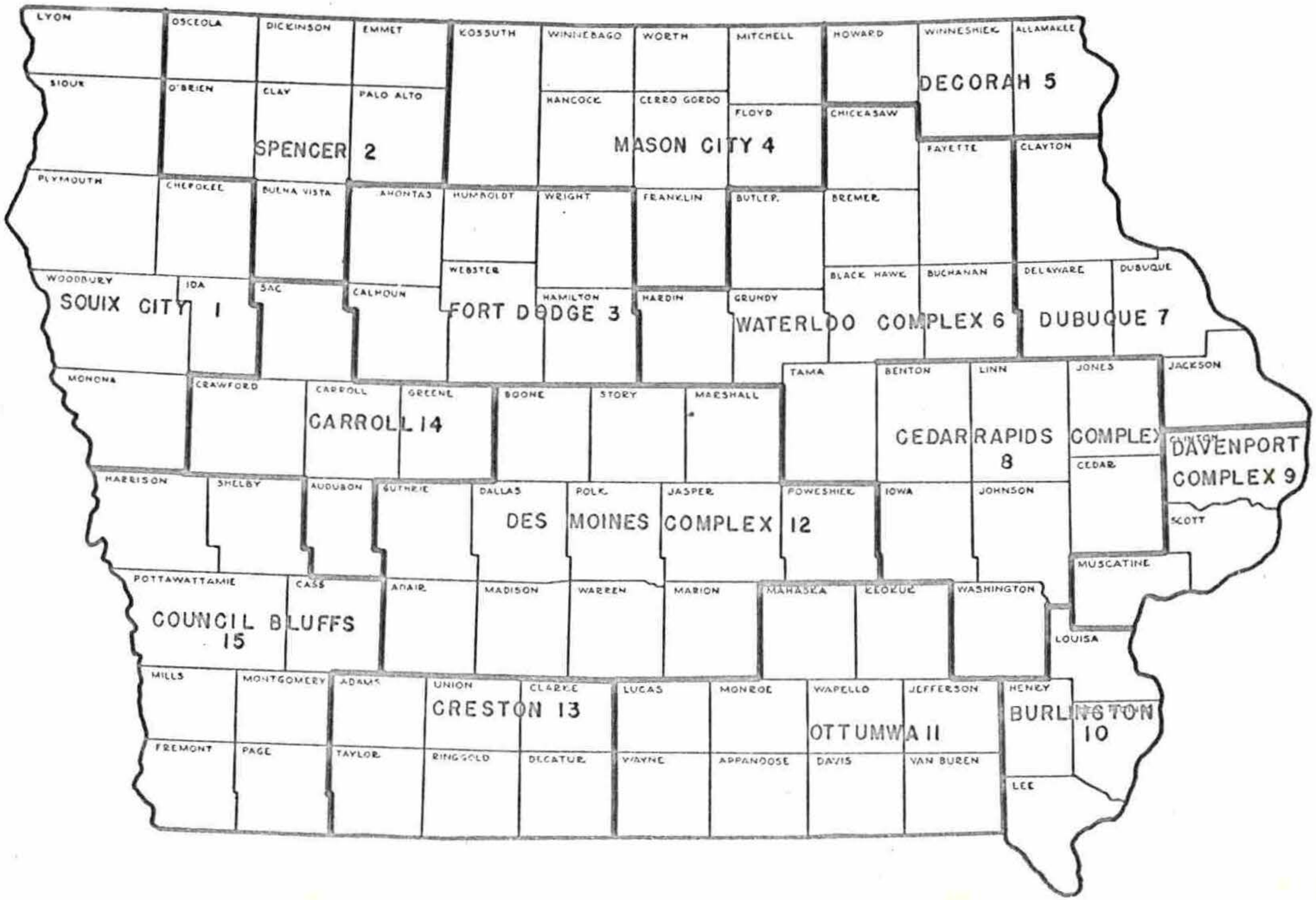
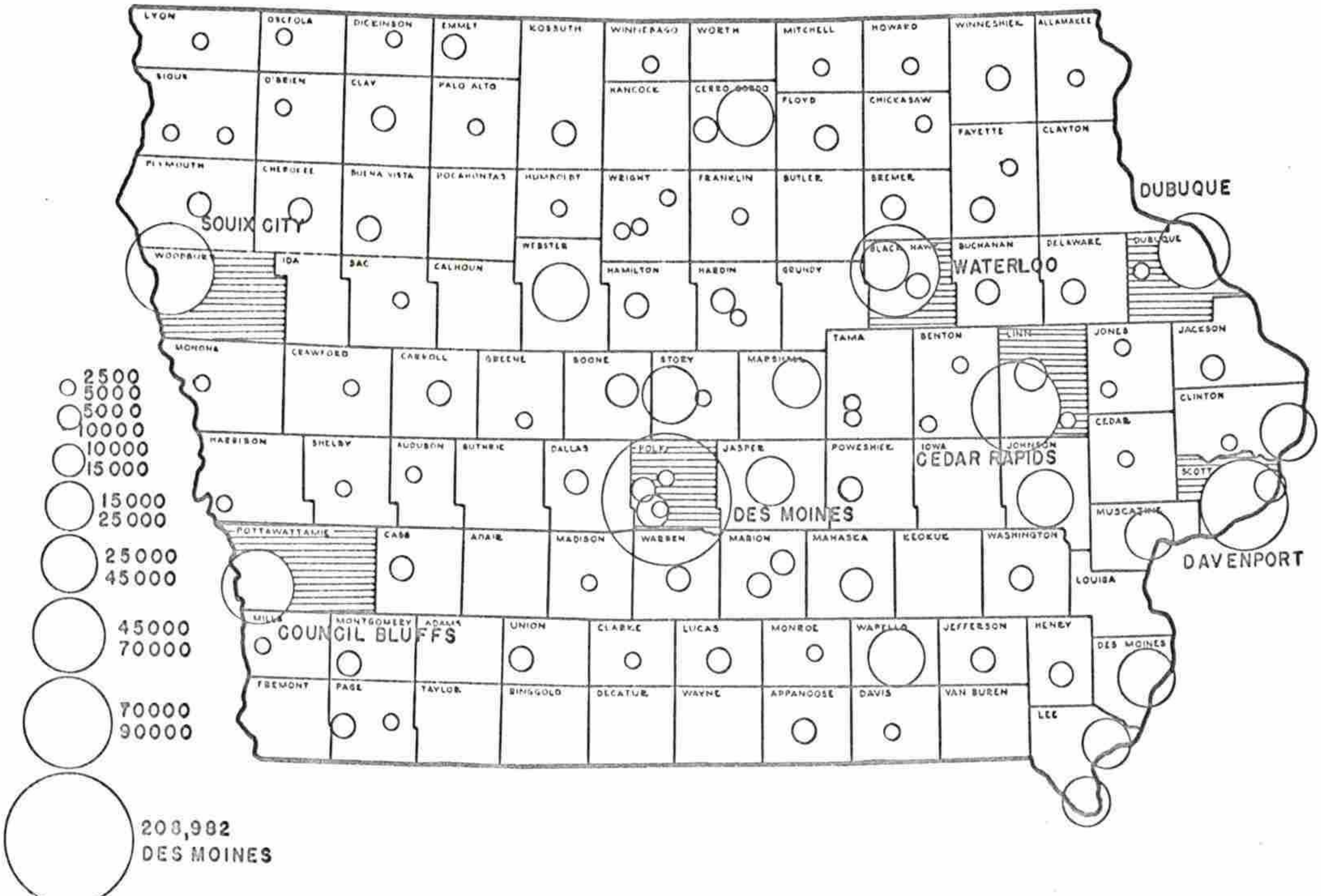


Figure 2. Fifteen Iowa functional economic areas identified by focal center

Figure 3. Iowa urban places and SMSA's[a] (22)

[a]Lined counties are Standard Metropolitan Statistical Areas (SMSA's).


LYON
OSCEOLA
DICKINSON
EMMET
KOSSUTH
WINNEBAGO
WORTH
MITCHELL
HOWARD
WINNESHIEK
ALLAMAKEE
SIOUX
O'BRIEN
CLAY
PALO ALTO
HANCOCK
CERRO GORDO
FLOYD
CHICKASAW
FAYETTE
CLAYTON
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
HUMBOLDT
WRIGHT
FRANKLIN
BUTLER
BREMER
DUBUQUE
SOUIX CITY
WOODBURY
IDA
SAC
CALHOUN
WEBSTER
HAMILTON
HARDIN
GRUNDY
BLACK HAWK
BUCHANAN
DELAWARE
DUBUQUE
WATERLOO
MONONA
CRAWFORD
CARROLL
GREENE
BOONE
STORY
MARSHALL
TAMA
BENTON
LINN
JONES
JACKSON
CLINTON
CEDAR
HARRISON
SHELBY
AUDUBON
GUTHRIE
DALLAS
POLK
JASPER
POWESHIEK
IOWA
JOHNSON
CEDAR RAPIDS
SCOTT
DES MOINES
MUSCATINE
DAVENPORT
POTTAWATTAMIE
CASS
ADAIR
MADISON
WARREN
MARION
MAHASKA
KEOKUK
WASHINGTON
LOUISA
MILLS
MONTGOMERY
ADAMS
COUNCIL BLUFFS
UNION
CLARKE
LUCAS
MONROE
WAPELLO
JEFFERSON
HENRY
DES MOINES
FREMONT
PAGE
TAYLOR
RINGGOLD
DECATUR
WAYNE
APPANOOSE
DAVIS
VAN BUREN
LEE
2500
5000
5000
10000
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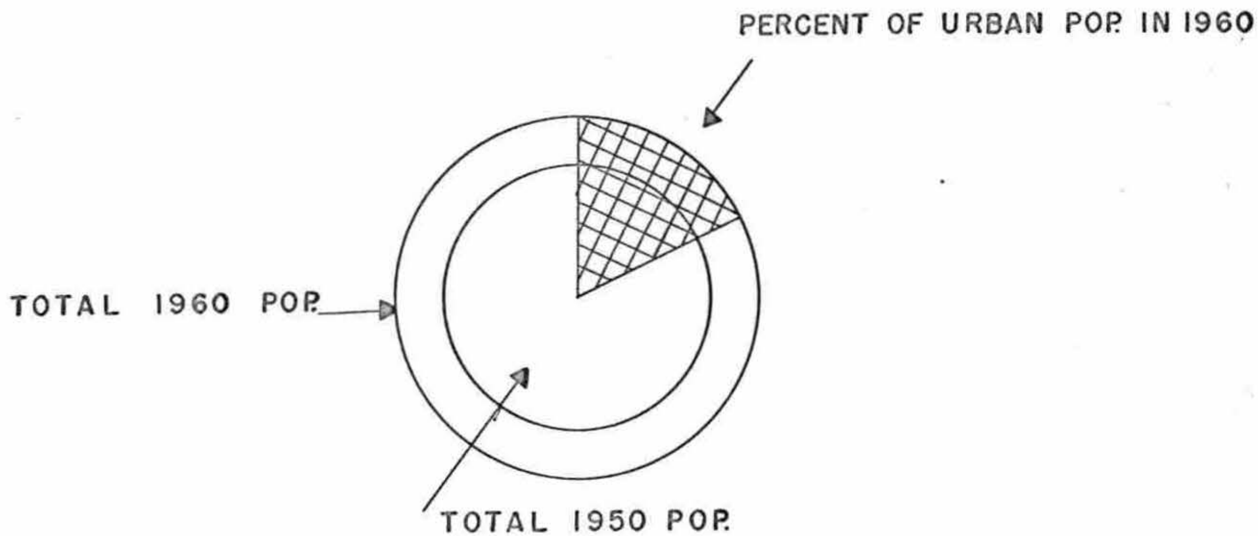
DES MOINES

12-62-1M


PERCENT OF URBAN POP. IN 1960
TOTAL 1960 POP.
TOTAL 1950 POP.

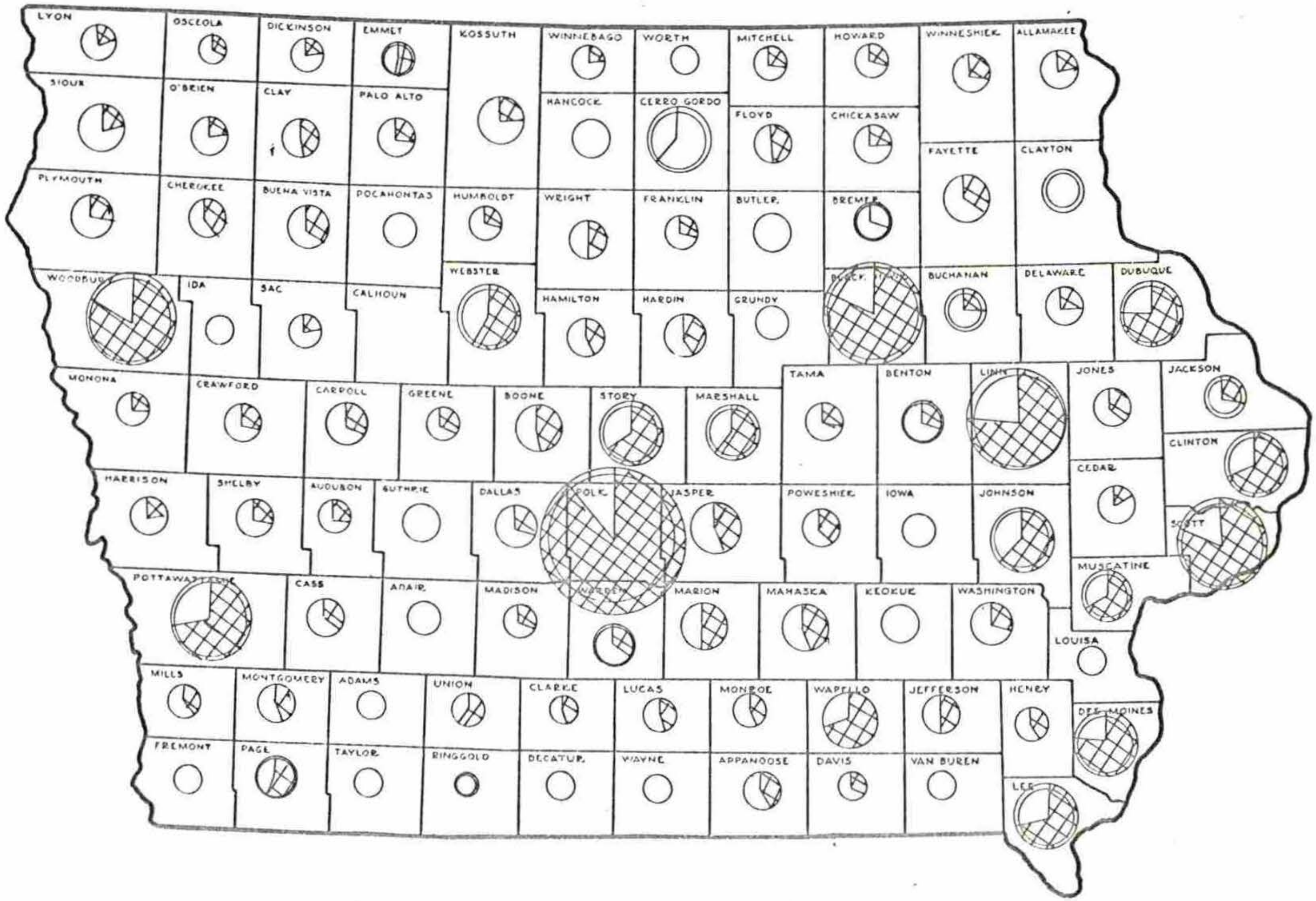
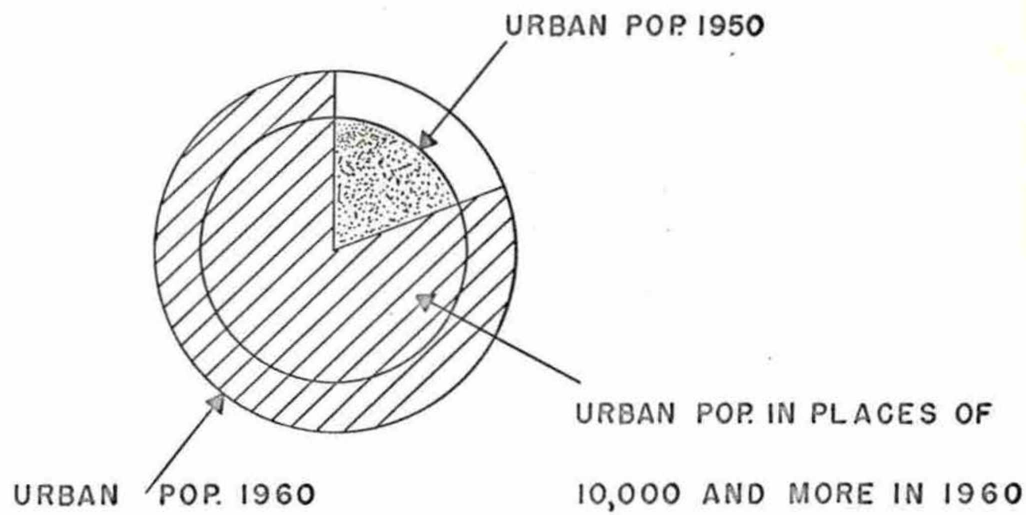


Figure 4. Percent of Iowa's population, by county, living in urban places, 1960


URBAN POP. 1950
URBAN POP. IN PLACES OF
10,000 AND MORE IN 1960
URBAN POP. 1960

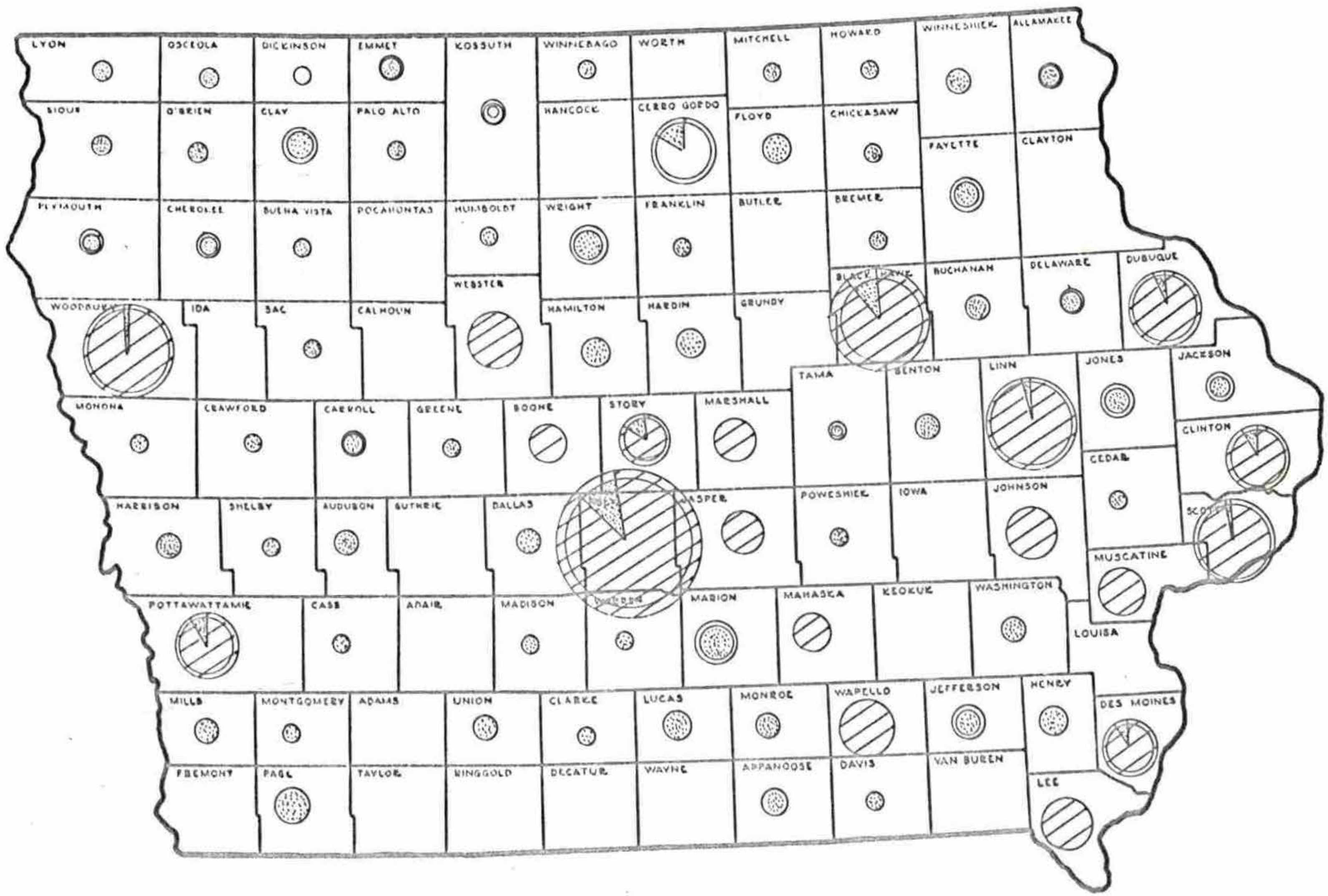


Figure 5. Percent of Iowa's urban population, by county, living in places of 10,000 or more

1. Population projections

Having looked briefly at the spatial distribution of urban population and places in 1950 and 1960 we now turn to the 1975 projection of Iowa's total population. This projection was prepared by Manley[3] using the Hamilton-Perry technique (38). This approach projects population by ten year age groups.

The assumptions of the method are (38, p. 165):

(1) There are no changes from one decade to the next in the relevant definitions of population and area boundaries.

(2) There are no changes from one decade to the next in age--specific rates of mortality and migration.

(3) The same errors of enumeration made in the past two decennial censuses will be made in the next census.

The model for projecting every age group, except children less than 10 years old (i.e., those born during the projection decade), is

$$P_i^{t+10} = (P_{i-10}^{t} \cdot P_i^{t})/P_{i-10}^{t-10} , \tag{32}$$

or

$$\frac{P_i^{t+10}}{P_i^{t}} = \frac{P_{i-10}^{t}}{P_{i-10}^{t-10}} , \tag{32a}$$

where P_i^{t+10} = total number of persons of the ith age group in year t+10;

P_i^{t} = total number of persons of the ith age group at the last decennial census in base year t; total number of persons

[3] Manley, Vaughn P., Iowa State University, Ames, Iowa. Unpublished population projections. Private communication. 1965.

P_{i-10}^{t} = total number of persons of the (i-10)th age groups at the last decennial census in base year t; and

P_{i-10}^{t-10} = total number of persons of the (i-10)th age group at the decennial census in year t-10.

Two additional models are used to project the "under 10" age class, namely,

$$P_{0-4}^{t+10} = P_{0-4}^{t} \frac{B^{(t+5)-(t+9)}}{B^{(t-5)-(t-9)}} , \tag{33}$$

and

$$P_{5-9}^{t+10} = P_{5-9}^{t} \frac{B^{t-(t+4)}}{B^{(t-10)-(t-6)}} , \tag{34}$$

where

P_{0-4}^{t+10} = total number of persons of the 0-4 age group in year t+10;

P_{0-4}^{t} = total number of persons of the 0-4 age group in base year t;

$B^{(t+5)-(t+9)}$ = total predicted number of births during the 5 year period from year t+5 through year t+9;

$B^{(t-5)-(t-9)}$ = total number of births during the 5 year period from year (t-5) through year t-9.

The variables for Equation 34 are similarly defined.

The estimated number of births, B^5, for a five year period is determined from the equation,

$$B^{(5)} = 5B = 5 \sum_j r_j^t P_j^t , \tag{35}$$

where

r_j^t = age-specific fertility rate for women of age j in base year t;

P_j^t = total number of women of age j at the middle of the base period; and

B = total predicted number of births per year for the 5 year period.

Table 1 shows Iowa's population projected to 1975 as well as the percentage of the population in each age group. The projections were made according to sex. Little change is forecase for the proportion of the population over 65; however Iowa has the highest proportion in this class of any state in the nation. In the age group from 25 to 64 years, which makes up most of the labor force, a considerable decline is expected. In 1960, 44 percent of Iowa's population fell into this class. By 1975 only 39.3 percent of the total population is expected to be in this class. The proportions of the population under 25 years of age has increased by approximately the same amount as the decline in the 25-64 age class, moving from 44.11 percent in 1960 to 49 percent in 1975. This increase in the proportion of youth in Iowa, combined with the greater decline within the 25-44 year age group, is the basis for the contention that Iowa exports substantial amounts of human capital in the form of employable young adults, many of them with college education.

The 1975 population estimate of 2,937,504 is an increase of 6.5 percent above the 1960 estimate. These estimates of total Iowa population are distributed by economic area in Figure 6. This spatial distribution is based on an aggregation of individual county estimates of population by age and sex prepared by Doerflinger[4]. The percentage change in area population ranges from an increase of 35.2 percent in the Cedar Rapids area to a decrease of 27.6 percent in the Creston area.

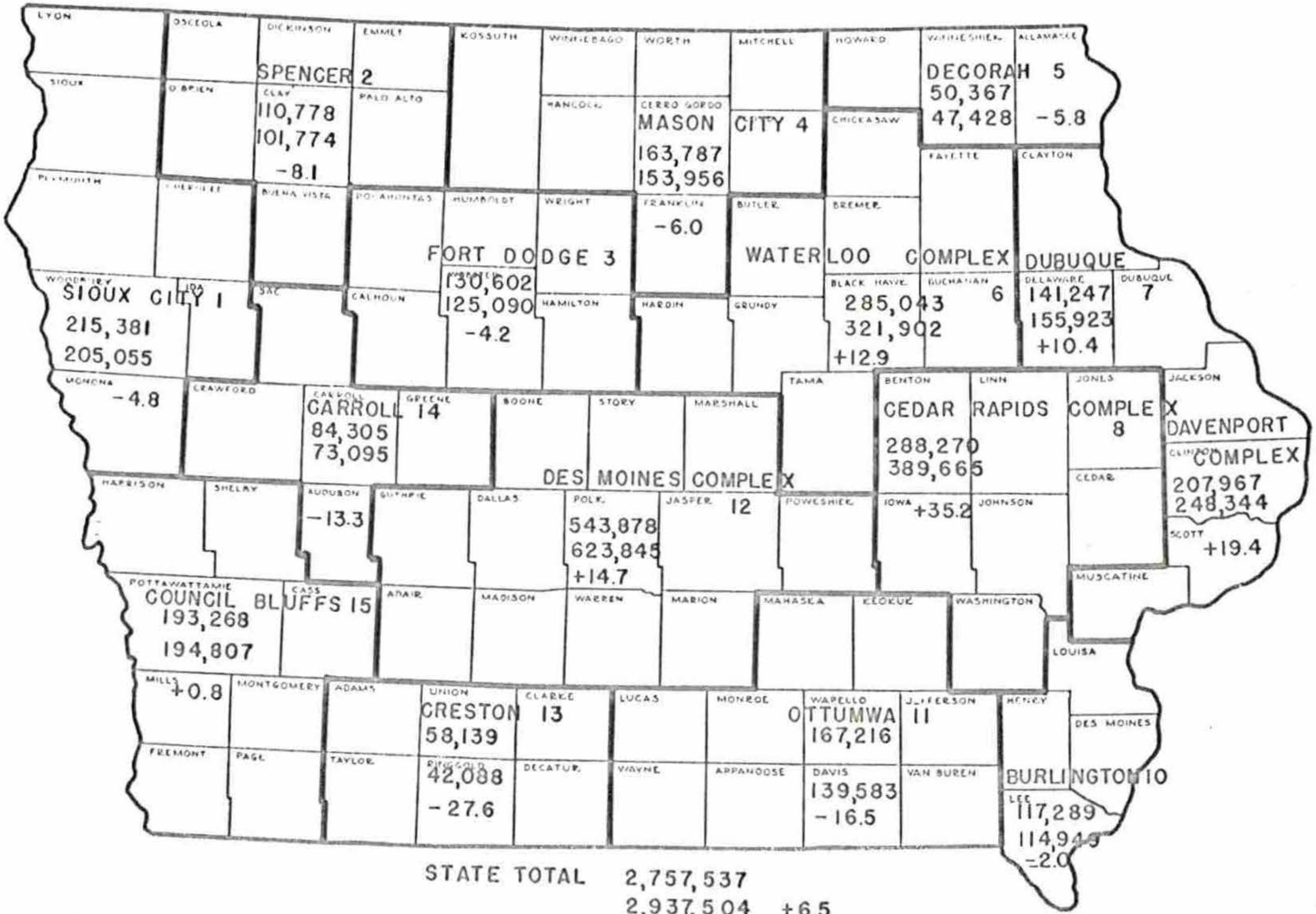
[4]Doerflinger, Jon. Iowa State University, Ames, Iowa. Unpublished Iowa county population projection. Private communication. 1965.

Table 1. Estimated population by age and sex, Iowa, 1950, 1960, and 1975

Item	Age in years						Total
	Under 10	10-14	15-24	25-44	45-64	65 and over	
Male							
1950	259,428	101,899	185,400	353,888	278,962	137,425	1,317,002
% of total pop.	9.84	3.86	7.03	13.42	10.58	5.21	49.94
1960	305,852	132,287	174,759	320,826	276,082	149,241	1,359,047
% of total pop.	11.09	4.80	6.34	11.63	10.01	5.41	49.28
1975	341,158	140,768	242,090	288,956	266,168	150,688	1,429,828
% of total pop.	11.61	4.79	8.24	9.84	9.06	5.13	48.67
Female							
1950	247,215	97,326	188,556	356,246	279,155	151,201	1,319,699
% of total pop.	9.38	3.69	7.15	13.51	10.59	5.73	50.05
1960	293,181	126,532	183,516	331,135	285,682	178,444	1,398,490
% of total pop.	10.63	4.59	6.66	12.01	10.36	6.47	50.72
1975	327,043	138,476	249,039	313,813	285,643	193,662	1,507,676
% of total pop.	11.13	4.71	8.48	10.68	9.72	6.59	51.31
Both							
1950	506,643	199,225	373,956	710,134	558,117	288,626	2,636,701
% of total pop.	19.22	7.55	14.18	26.93	21.17	10.94	99.99[a]
1960	599,033	258,819	358,275	651,961	561,764	327,685	2,757,537
% of total pop.	21.72	9.39	13.00	23.64	20.37	11.88	100.00
1975	668,201	279,244	491,129	602,769	551,811	344,350	2,937,504
% of total pop.	22.74	9.50	16.72	20.52	18.78	11.72	99.98[a]

[a]Percentages do not add to 100 percent because of rounding.

Figure 6. Total Iowa population and percentage change by area, 1960-1975



TOP FIGURE = 1960 POP.
2ND " = 1975 POP.
3RD " = % CHANGE 1960-75

2. Incorporated population

The remainder of this analysis is directed toward the Iowa population living in incorporated places. There are two reasons for this choice. First, nearly 75 percent of Iowa's population will be living in such places by 1975. While the number of unincorporated Iowa towns is large (approximately one third the total for all towns), the population and growth potential in such places is small. For example, in 1960 the Fort Dodge area had a total of 94 towns, 32 of which were unincorporated. These 32 towns, however, accounted for a total population of only 1,990 or 1.5 percent of the total area population. The other reason for dealing only with incorporated towns is that we are concerned with testing some analytical procedures for which data are readily available.

The proportion of Iowa's population living in incorporated towns has increased steadily since 1900, with the most uniform trend taking place since 1920. Figure 7 shows this trend plotted from 1900 to 1975. The 1975 estimate is based on the equation,

$$\log Y = 1.701387 + .022335 X, \qquad (36)$$

where

Y = proportion of total population living in incorporated towns; and

X = time index (e.g. 1920 = 2, 1930 = 3, etc.)

The fitting of this model resulted in a simple correlation coefficient r, of 0.992 and a "t" value that denotes significance at the 0.01 probability level. The 1975 estimate is 74 percent, which means an incorporated population of 2,172,284, based on the total projected population of 2,937,504.

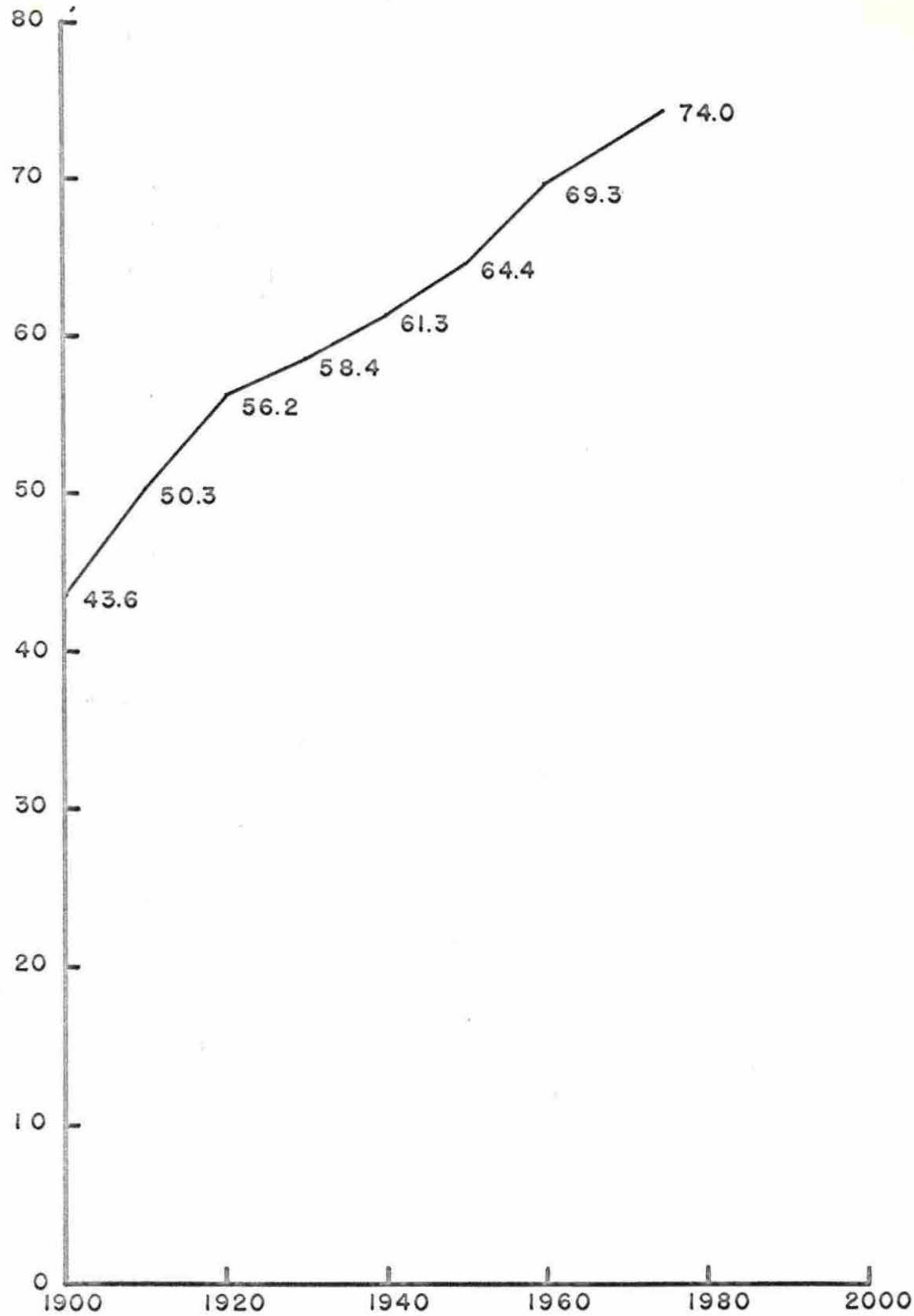


Figure 7. Proportion of Iowa population living in incorporated places, 1900-1975

This incorporated population has been distributed by area using a proportional relationship technique similar to that used in distributing total population. The relationship was derived from a graphic projection of incorporated area population. Table 2 shows the results of this distribution together with the change in incorporated population since 1960. The percentage change is also shown by FEA on the map in Figure 8.

Implications for focal center development can be more readily inferred by examining the relationship of "central city" population to total incorporated population. Figures 9 and 10 show the trend in the percentage of total Iowa incorporated place population that lives in the focal center. By fitting a linear regression for each area to 1920-1960 data, 10 of the 15 areas show an increasing percentage of the total area "incorporated" population in the focal centers. The correlation matrix shows for these 10 areas coefficients ranging from 0.909 to 0.987. For the other five areas no positive linear trends are apparent. The central cities of these areas were Creston, Mason City, Cedar Rapids-Marion, Sioux City, and Burlington. There are two types of explanation for this difference in focal center growth. The first explanation applies to the Creston area. Because of its size, location and the nature of the area, Creston simply does not perform the full range of functions of a focal center.

The second explanation applies to the other four areas. We might call this explanation "adjacentness". Adjacentness refers to the existence of a city or cities within the region that is not contiguous to the focal center but that performs some of the functions of the focal

Table 2. Incorporated FEA population change 1960 - 1975

	Area	1960[a]	1975	Change	Percentage change
1.	Sioux City	152,748	160,749	8,001	5.2
2.	Spencer	65,728	73,858	8,130	12.4
3.	Fort Dodge	82,262	89,064	6,802	8.3
4.	Mason City	97,829	106,442	8,613	8.8
5.	Decorah	22,695	23,895	1,200	5.3
6.	Waterloo Complex	194,504	234,607	40,103	20.6
7.	Dubuque	95,361	106,442	11,081	11.6
8.	Cedar Rapids Complex	204,025	265,019	60,994	29.9
9.	Davenport Complex	176,057	210,711	34,654	19.7
10.	Burlington	87,713	95,580	7,867	9.0
11.	Ottumwa	104,543	97,753	-6,790	-6.5
12.	Des Moines Complex	418,632	497,453	78,821	18.8
13.	Creston	30,577	26,067	-4,510	-14.7
14.	Carroll	45,981	47,790	1,809	3.9
15.	Council Bluffs	130,590	136,854	6,254	4.8
	Total	1,909,245	2,172,284	263,039	13.8

[a]Source: U. S. Census (83).

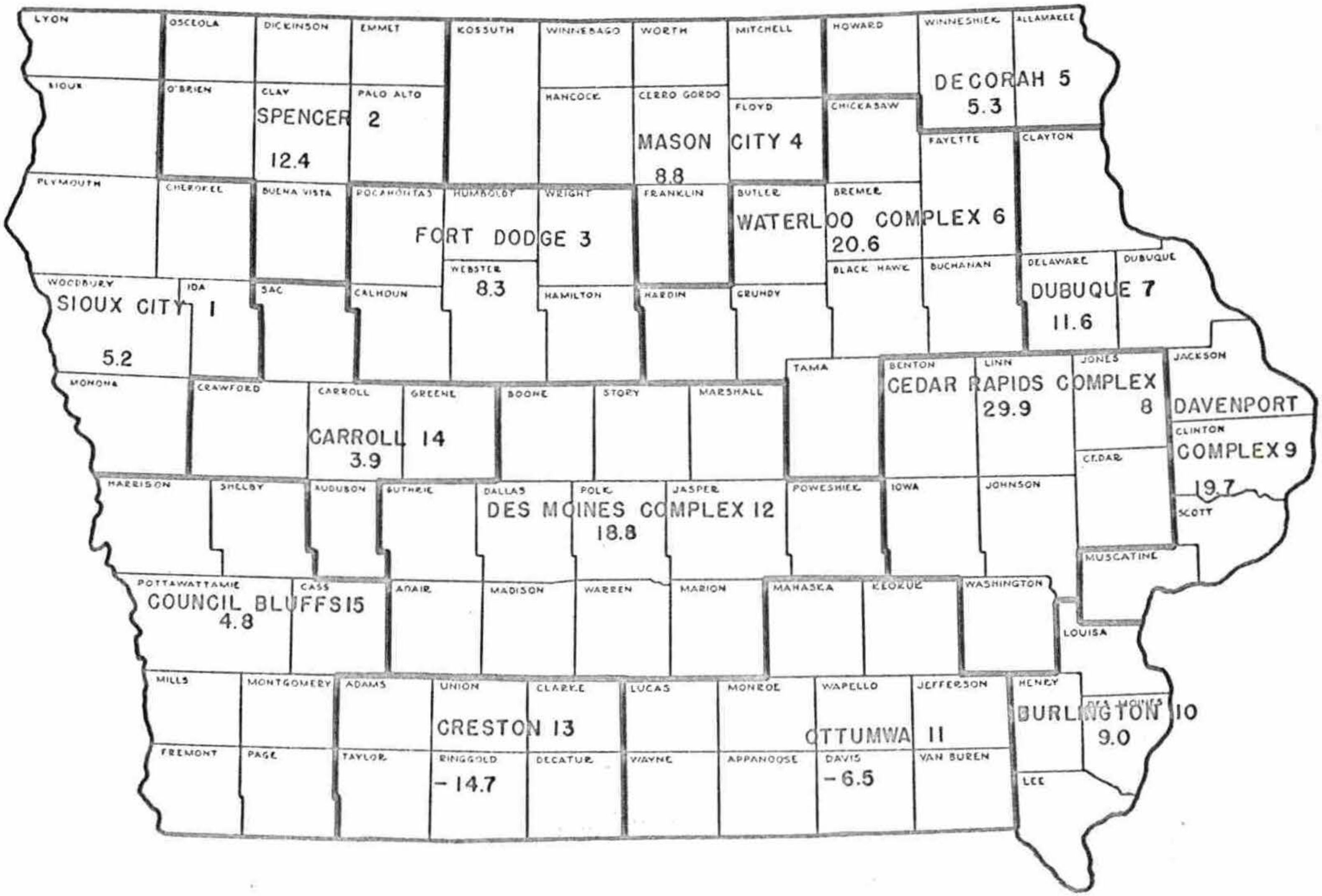


Figure 8. Percentage change in incorporated Iowa population by area, 1960-1975

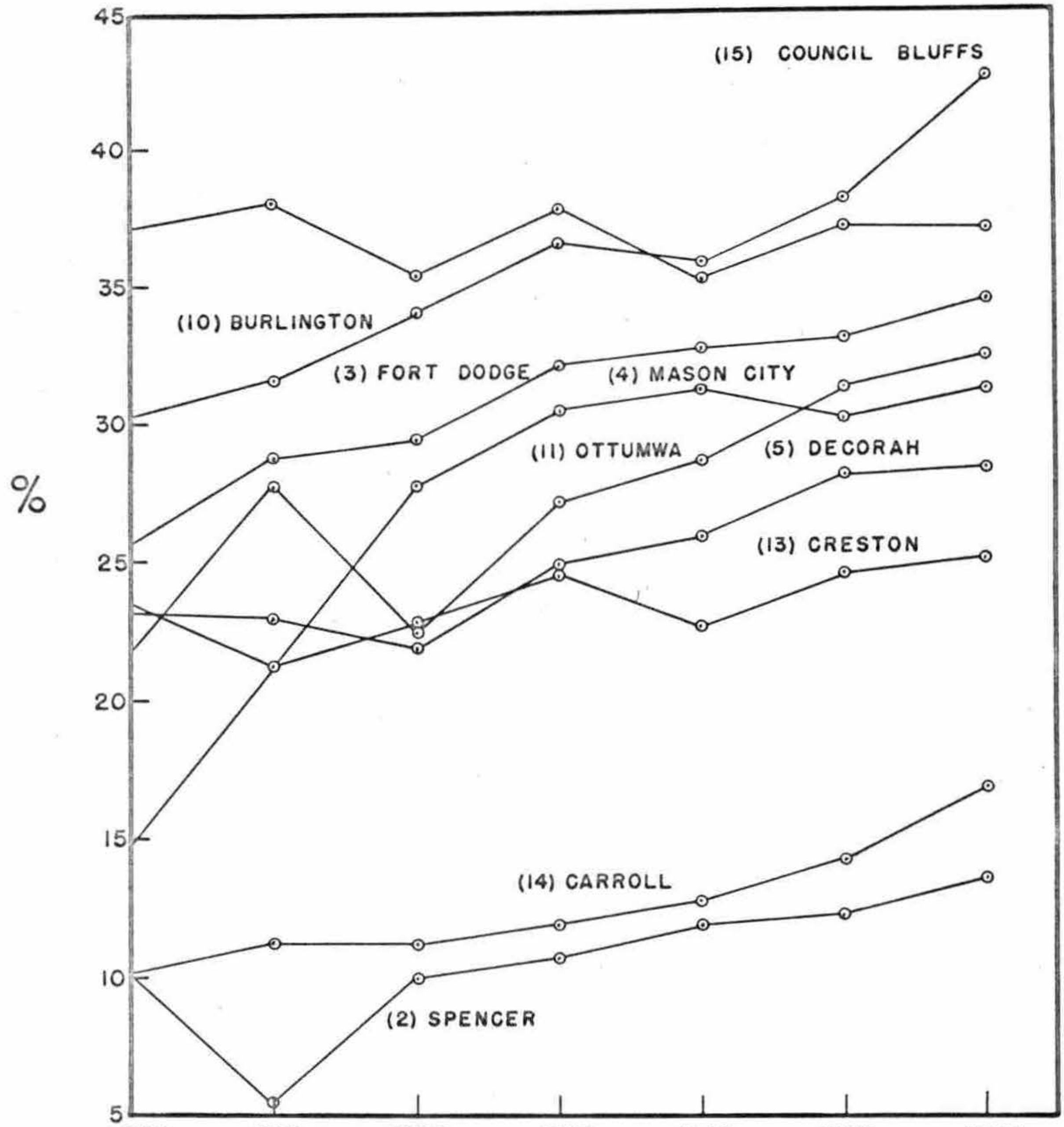


Figure 9. Percentage of incorporated area population living in the focal center, trend 1900-1960

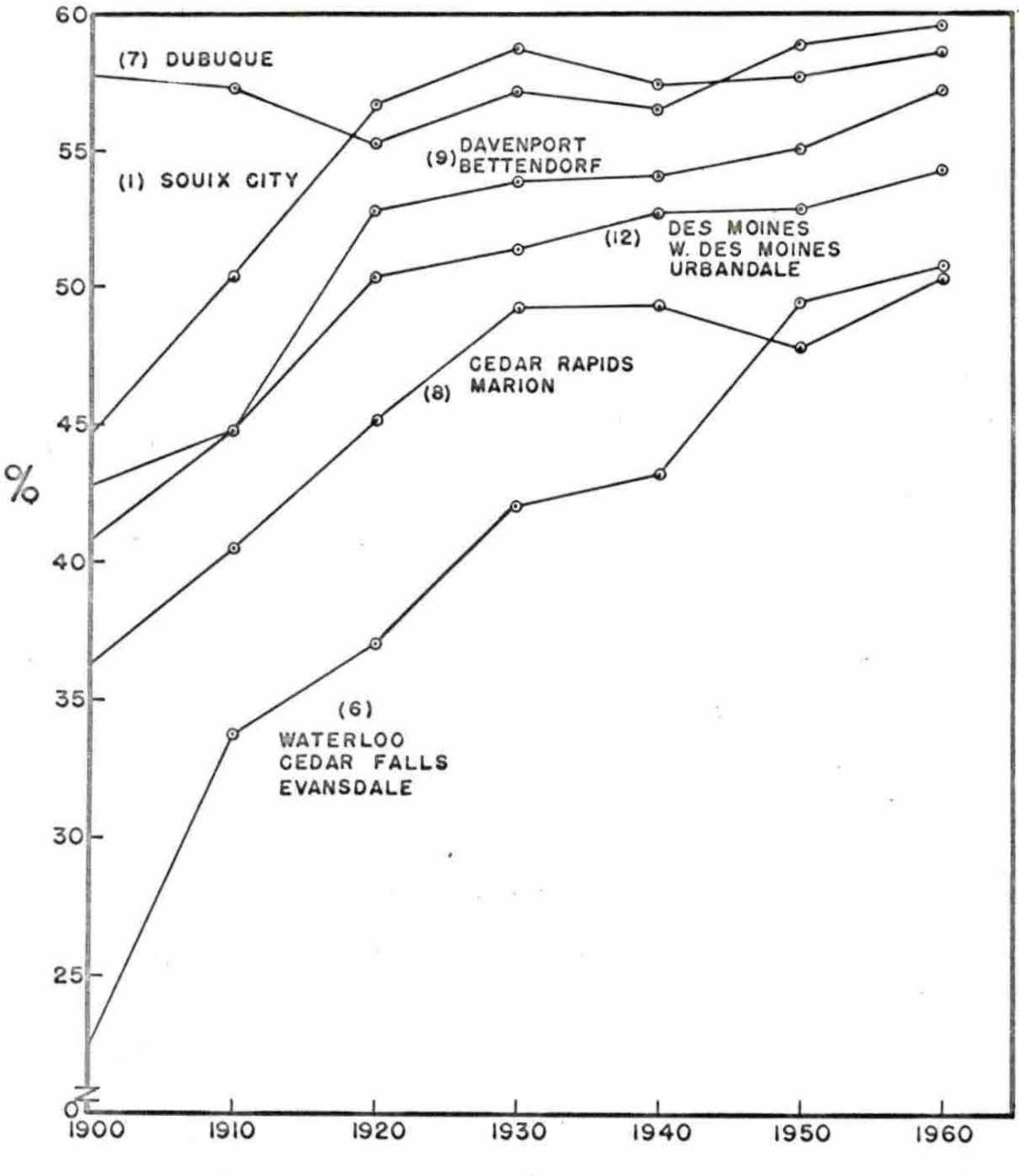


Figure 9. (Continued)

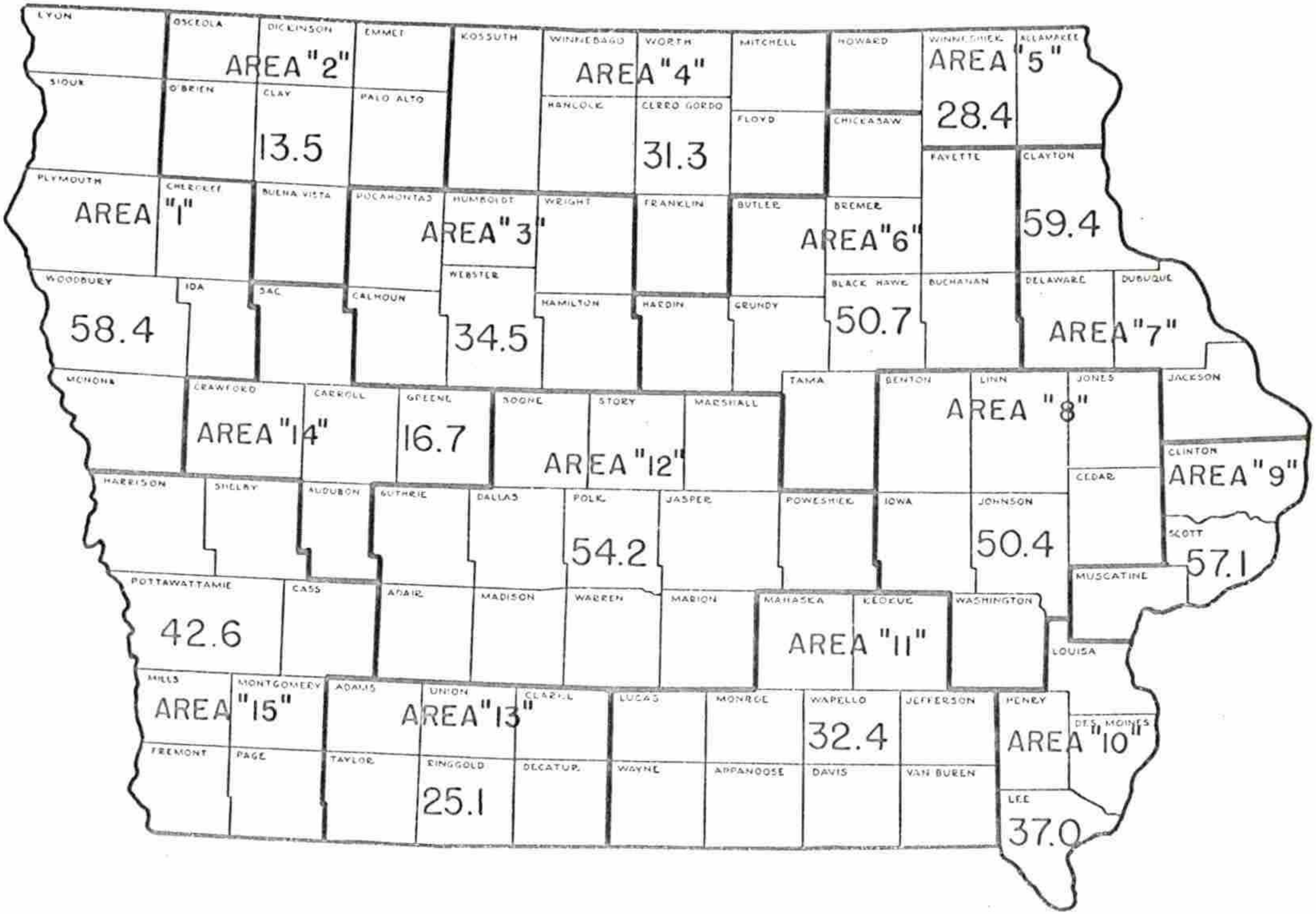


Figure 10. Percentage of incorporated area population living in the focal center, 1960

center. This accounts for lack of uniformity in the proportional growth trend of the central city. In the Cedar Rapids area, for example, is Iowa City, in the Burlington area is Fort Madison, and in the Mason City area is Clear Lake. In the Sioux City area there is no single city but rather several small towns located on the four lane highway system leading into Sioux City from the north, east, and south.

The first hypothesis is difficult to test concretely. The second hypothesis, however, is tested for the Mason City area. The test simply involves treating Clear Lake's population as a part of the focal center population and calculating the proportion of incorporated population in the "central city" for 1920 through 1960 using these new figures. Fitting a regression model to these new proportions over time, we obtain an increasing linear trend, a correlation coefficient of 0.950 and a "t" value that is significant at the 0.01 probability level. These results point out the importance of the relationships between cities. The role of the central city cannot be assessed by considering it alone.

3. Size class distribution

At this point, the analysis is directed toward the distribution of incorporated towns within given size classes, and eventually the incorporated population by size class. In Chapter II we discussed two analytical techniques, Pareto functions and Markov chains, that lend themselves to such investigations. The Pareto function, or rank size rule, has been widely used (6, 10, 57, 88, 71) for some time to explain the size distribution of cities. It has achieved widely varying results and support ranging from Singer (71) who says the rule "works well" to Moore (57) who says the rule is "quite unsatisfactory". On the basis of this study we also find the rule "quite unsatisfactory". In its pure theoretical form, as noted in Chapter II, the rank-size rule is defined by the equation,

$$Y = BP^{-q} \tag{37}$$

where q = 1 and B is the population of the first ranking city. By converting this model into log form, and applying it to the 1960 distribution of incorporated Iowa towns for a check, a predicted distribution is obtained (Table 3). The correspondence between actual and predicted values is not high. The model predicts a total of 20,900 towns compared to 944 actual, which is an error of over 2,000 percent.

A second approach to the rank-size concept is to fit the model to actual data and estimate the parameters B and q. This was done, again using a log model and 1960 data. A regression coefficient of 0.940 and a significant "t" value (at the 0.01 probability level) was obtained, which indicates a satisfactory fit; however, when we convert from the log values to actual town projections these results are not much improved over the purely theoretical estimates. The results appear in Table 4. The graphical distribution of incorporated places in Figure 11 indicates that for towns between 200 population and 50,000 or more population, some predictive capability is provided by the rule. Results of this fit (for which r = 0.977) appear in Table 5. Again, though the fit of the logarithmic model was excellent, the conversion to the original units (i.e., number of towns) and a comparison with the actual data produced poor results. This is, of course, understandable because a small change in a log will result in an exponential change in the

Table 3. Theoretical[a] cumulative Pareto distribution of incorporated Iowa towns, 1960

Number of towns larger than specified size	Lower limit of size class of incorporated place									
	10	200	500	1,000	1,500	2,500	5,000	10,000	25,000	100,000
Actual distribution[b]	944	746	450	238	160	104	58	25	14	1
Theoretical Pareto distribution[a]	20,900	1,045	418	209	139	84	42	21	8	2
Difference	19,956	299	-32	-27	-21	-20	-16	-4	-6	1

[a]Theoretical refers to a q equal to one and a B equal to the population of the largest town in the model $Y = BP^{-q}$.

[b]Source: (69).

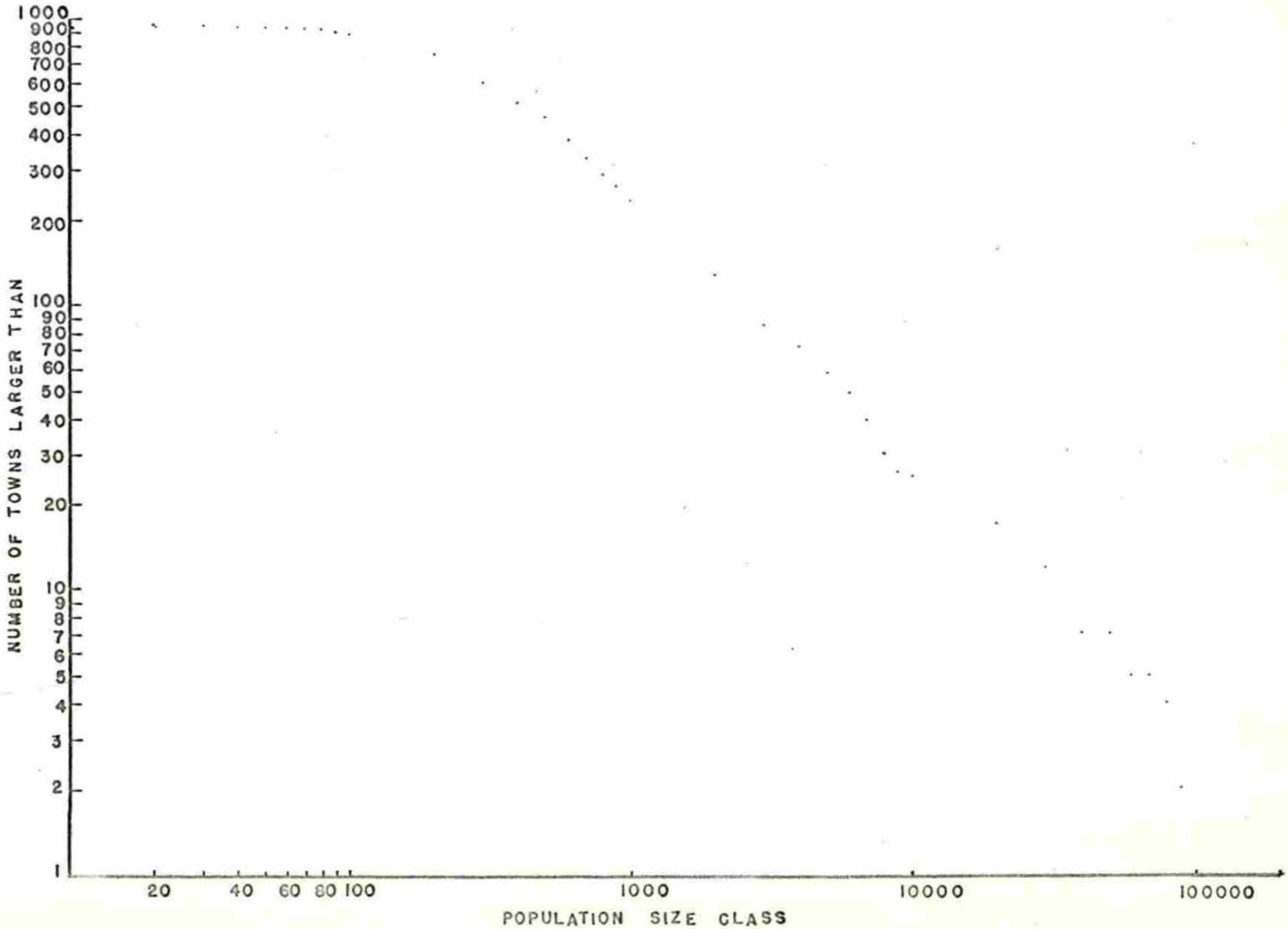
Table 4. Fitted[a] cumulative Pareto distribution of incorporated Iowa towns, 1960

Number of towns larger than specified size	Lower limit of size class of incorporated place									
	10	200	500	1,000	1,500	2,500	5,000	10,000	25,000	100,000
Actual distribution[b]	944	746	450	238	160	104	58	25	14	1
Fitted Pareto distribution[a]	4,467	438	215	125	91	61	36	21	10	3
Difference	3,523	-308	-235	-113	-69	-43	-22	-4	-4	2

[a] $q = 0.77802$, $\log Y = 4.43205-(o.77802) \log P$.

[b] Source: (69).

Figure 11. Size distribution of incorporated Iowa places, 1960


NUMBER OF TOWNS LARGER THAN
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
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40
30
20
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9
8
7
6
5
4
3
2
1
20
40
60
80
100
1000
10000
100000
POPULATION SIZE CLASS

Table 5. Fitted[a] Pareto distribution of incorporated Iowa towns with population of 200 or more in 1960

Item	Population of incorporated place								
	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 and up	Total
Actual distribution	296	212	78	56	46	33	11	14	746
Pareto distribution[a]	529	193	68	57	46	24	16	13	946
Adjusted Pareto distribution	417	152	54	45	36	19	13	10	746
Difference	121	-60	-24	-11	-10	-14	2	-4	

[a] $\log Y = 5.03372-(0.89438) \log P.$

actual number[5].

To insure that the resulting distribution is unsatisfactory, the projected distribution was adjusted proportionately to the same total as the actual distribution and a chi square test was performed. The hypothesis tested was that there was no difference between the two distributions. The chi square value calculated was 238, which is highly significant; therefore, the hypothesis is rejected.

On the basis of the analysis we conclude that the usefulness the Pareto function or rank-size rule in predicting the size distribution of cities in a given area is questionable.

The second technique, the Markov process approach, is more satisfactory and reliable. The Markov procedure is based on the assumption that the probability of a town moving from one size class to another during a decennial census period is derived from the shift of towns that took place between those two size classes during the previous decennial census period.

The procedure was tested by projecting the 1960 distribution of incorporated Iowa towns. The projection model is based on a transition probability matrix that depicts the movement of towns among classes during the 1940-1950 decade. A comparison of the projected results and the actual number of towns per size class appears in Table 6. Subjecting the distribution to a chi square test yields a chi square of 2.78 which is not significant; therefore, we accept the hypothesis that the two frequencies are not significantly different.

[5]For example, the log 10 = 1 while the log 100 = 2, a difference of 100 percent yet there is a difference of 900 percent between 10 and 100.

Table 6. Markov projection of Incorporated Iowa towns, 1960

Procedure	Population size class of incorporated place											
	0 to 199	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up	Drop outs	Total
Markov projection	195	313	207	71	59	42	32	11	14	1	2	947
Actual	198	296	212	78	56	46	33	11	13	1	3	947
Difference	-3	17	-5	-7	3	-4	-1	0	1	0	-1	0

Having tested the procedure and found it reliable, we are now prepared to project the 1975 distribution of incorporated Iowa town. Table 7 shows the transition probability matrix used for the projections together with the 1950-1960 actual transitions from which it was derived. The 1975 projections are based on a linear interpolation between the 1970 and the 1980 projections. Some adjustment was necessary in the upper two size classes because there was no transition between these two classes during the 1950-1960 period while a graphic analysis of the growth trends of the larger towns showed that at least two towns, Cedar Rapids and Davenport, will have passed the 100,000 population level by 1975. In Table 8 the results of the projections, together with the estimated change and percentage change from 1960 to 1975, are presented. One noteworthy trend presented is the increase of 11 towns larger than 5,000, the increase of 18 towns smaller than 200, and the decrease of 15 towns between 200 and 5,000.

Table 9 shows the distribution of our previously derived 1975 population by town size class. The proportions for distributing this population were obtained by applying 1975 number of towns per size class to a graphic estimate of average town size per class to derive a total incorporated population estimate. Again, the upper classes received special analysis because the shifts of town among these large size classes account for considerable fluctuation in their average size. For the top three classes a graphic projection was made for each individual city. Total incorporated population derived in this fashion was within 4.5 percent of the more sophisticated projection. This more sophisticated figure of 2,172,284 was distributed among size classes according

Table 7. Population trends in incorporated Iowa towns

Year t[a]	Year t + 10: 0 to 199	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up	Drop outs	Total
0 to 199 (Probability)	170 (93.4)	11 (6.0)									1 (0.6)	182 (100.0)
200 to 499	25 (7.7)	271 (83.9)	25 (7.7)	1 (0.3)							1 (0.3)	323 (100.0)
500 to 999		8 (3.9)	178 (86.0)	19 (9.2)	1 (0.5)						1 (0.5)	207 (100.0)
1,000 to 1,499			7 (9.7)	54 (75.0)	9 (12.5)	2 (2.8)						72 (100.0)
1,500 to 2,499				2 (3.5)	46 (80.7)	8 (14.0)	1 (1.8)					57 (100.0)
2,500 to 4,999						36 (85.7)	6 (14.3)					42 (100.0)
5,000 to 9,999							25 (89.3)	3 (10.7)				28 (100.0)
10,000 to 24,999							1 (10,0)	8 (80.0)	1 (10.0)			10 (100.0)
25,000 to 99,999									12 (100.0)			12 (100.0)
100,000 and up										1 (100.0)		1 (100.0)
New towns	3 (23.0)	6 (46.1)	2 (15.4)	2 (15.4)								13 (100.0)
Total	198	296	212	78	56	46	33	11	13	1	3	947

[a]t = 1950.

Table 8. Size distribution of incorporated Iowa towns, 1960-1975

Item	Size of incorporated place										
	0 to 199	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up	Total
1960 No. of towns	198	296	212	78	56	46	33	11	13	1	944
Percentage change	9.1	-10.1	1.4	9.0	1.8	8.7	21.2	18.2	0.0	200.0	1.5
1975 No. of towns	216	266	215	85	57	50	40	13	13	3	958

Table 9. Total population of incorporated Iowa towns, 1960-1975

Item	Size of incorporated place										
	0 to 199	200 to 499	500 to 999	1,000 to 2,499	1,500 to 1,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up	Total
1960 Pop.	25,446	94,646	147,203	94,648	106,779	161,370	227,074	169,543	673,554	208,982	1,909,245
Percentage change	0.7	-15.3	-3.3	5.1	-1.5	6.5	13.6	23.2	-7.5	1119.0	13.8
1975 Pop.	25,633	80,157	142,285	99,491	105,138	171,826	258,067	208,974	623,011	457,700	2,172,284

to the proportion of Markov-graphic projection in a given class.

Looking at the predicted changes in incorporated population between 1960 and 1975 we note that the increase in the population of towns larger than 5,000 is 268,559 or 5,560 greater than estimated total increase. Since the change in population of towns under 200 was only 187, this implies the population of so-called "middle-sized" towns decreased by 5,373. The average size of towns smaller than 200 is decreasing since their increase in number of 9.1 percent far exceeds increase of 0.7 percent in the population of the class. This is consistent with the finding of Borchert (14) who found fewer people living in more small towns in the upper Midwest.

B. Analysis of the Six County Area

We now turn our attention briefly to the population system of the Fort Dodge area. Figure 12 presents the spatial distribution of incorporated towns. While the 1975 projection of total population (Figure 6) predicts a decrease in total area population of 4.2 percent, incorporated population is expected to increase by 8.3 percent. This shift in population concentrations and location is consistent with the decline in farm population and the increase in out-migration. This shift also implies employment structure and helps to explain the projection in Chapter IV which show an increase in 1975 employment while total population is declining.

Table 10 shows the Markov projection of the size class distribution of incorporated towns. We see the same decline in "middle-size towns" as was noted for the state distributions though this middle range is

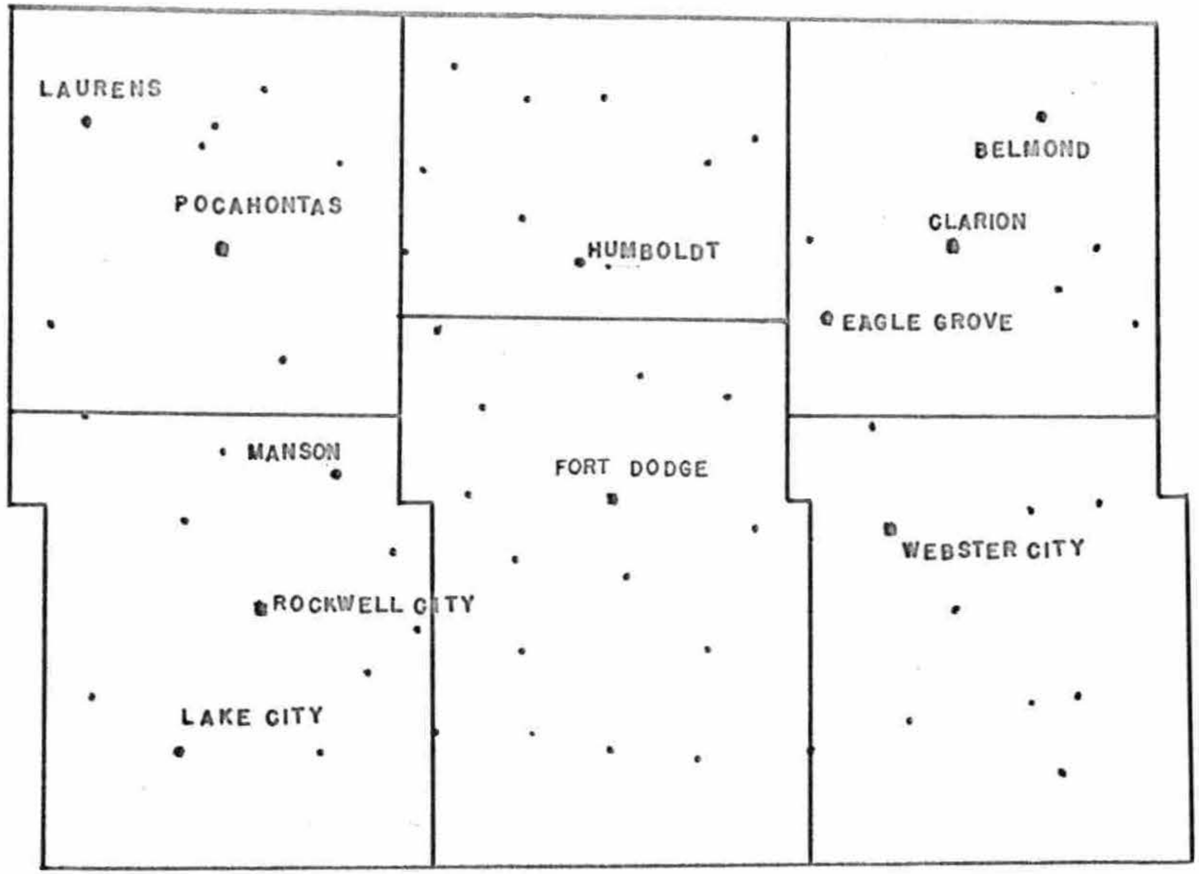

Figure 12. Fort Dodge area incorporated places

Table 10. Size distribution of incorporated Fort Dodge area towns, 1960-1975

Item	Size of incorporated place										
	0 to 199	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up	Total
1960 No. of towns	13	23	12	3	5	4	1	0	1	0	62
Percentage change	0.0	13.0	-16.7	33.3	-20.0	50.0	0.0	0.0	0.0	0.0	4.8
1975 No. of towns	13	26	10	4	4	6	1	0	1	0	65

smaller, (towns of 500 to 2,500) because of the smaller total range of town size in this area.

This concludes our analysis of population *per se*. We summarize the finding as follows:

(1) There is a wide range in the size of focal centers.

(2) There is a movement of population toward larger cities.

(3) Population projections imply a continued out-migration of human capital in the form of educated young people.

(4) We cannot assess economic activity for an area on the basis of focal population alone because of adjacentness.

(5) There is a tendency for the number of "middle size" towns to decrease while the number of small and larger towns increase.

(6) The findings for the Fort Dodge area are consistent with state findings.

In the next chapter we will examine the labor force in the six-county area. By using employment data and the techniques of shift analysis and economic base analysis, we will attempt to analyze economic shifts and changes in the six-county area.

IV. BASIC AND SERVICE INDUSTRY IN THE FORT DODGE AREA

A crucial point in a regional economic base study is the determination of which industries are basic and which are service. The most accurate method of obtaining information on the products exported, and their quality, is by the interviewing of each firm in a sample regarding the proportion of its sales that are made outside the area. According to Leven (49) this is the only approach to follow; however, this procedure involves considerable field work.

A. Location Coefficients

The method which will be used here is the more common and less exact approach of location coefficients. These coefficients are derived by comparing the proportion of total employment in a given industry, P_i, for the nation with the proportion employed in that industry, p_i, for a given region. The location coefficient is defined as the ratio, $\frac{p_i}{P_i}$. If $\frac{p_i}{P_i} > 1$, then the ith industry is a basic or export industry. If $\frac{p_i}{P_i} \leq 1$ then the ith industry is a service or import industry. The weakening assumption of this technique is, of course, that "...local patterns of use and habits of consumption are the same as average national ones, and that all local demands are served by local production (45, p. 195)". While this approach may not give exact cardinal results, it has considerable value in revealing trends.

Table 11 shows the location coefficients for the Fort Dodge area in 1950 and 1960 for 12 major industrial categories based on census

Table 11. Fort Dodge area location coefficients for 1950 and 1960

Industry	Coefficients	
	1950	1960
Agriculture	2.7817	3.9169
Mining	0.1394	0.2277
Manufacturing	0.4093	0.5877
Transportation	0.8836	0.8939
Communication & public utilities	0.7774	0.8421
Wholesale trade	1.2069	1.0292
Retail trade	1.0152	1.1350
Finance, insurance & real estate	0.5882	0.6619
Services	0.8311	0.8712
Contract construction	0.9723	0.8237
Public administration	0.5740	0.6431
Industry not reported	0.8926	0.4988

industrial classifications. Ignoring the category of "industry not reported" there are three industries that are basic to the area. The most predominant, as would be expected, is agriculture, while retail and wholesale trades are also basic. Wholesale trade is declining in importance while retail trade is increasing. The actual employment figures are shown for comparative purposes in Table 12. The calculation of the location coefficient also permits calculation of the basic service ratio.

The basic service ratio is the ratio of employment in export activities to employment in non-export industries. For 1950, $R_{50} = \frac{11,748}{36,248} = 0.324$, and for 1960 $R_{60} = \frac{10,145}{36,355} = 0.278$.

The trend, thus, is toward an increasing proportion of employment in service industries. If we look at the situation in the context of a regional employment multiplier, that is, total employment divided by basic employment--this multiplier has increased from 4.08 to 4.59 during the period from 1950 to 1960. This is a slightly different presentation of the same implication: service employment is increasing relative to basic employment. It should be noted that the industrial category "services" is not identical in meaning to the concept of a service or non-exporting industry. It is in the sense that its location coefficient is less than one, however, that services is called a "service" industry. This use of the term also explains the apparent anomaly in classifying manufacturing as a "service" industry.

Table 13 shows the percentage of area employment by industrial category which is found in Fort Dodge. It can be noted, also, that

Table 12. Fort Dodge area excess-deficit (basic-service) employment, 1950 and 1960

Industry	Employment					
	Actual 1950	Economic Base 1950	Difference	Actual 1960	Economic Base 1960	Difference
Agriculture	16,635	5,980	10,655	12,308	3,142	9,166
Mining	108	775	-667	108	474	-366
Manufacturing	5,113	12,492	-7,379	7,418	12,622	-5,204
Transportation	2,221	2,513	-293	1,767	1,977	-210
Communication & public utilities	991	1,275	-284	1,042	1,237	-195
Wholesale trade	2,014	1,669	345	1,642	1,595	47
Retail trade	7,375	7,265	110	7,838	6,906	932
Finance, insurance & real estate	962	1,635	-673	1,285	1,941	-656
Services	7,134	8,584	-1,450	8,507	9,765	-1,258
Contract construction	2,860	2,941	-81	2,263	2,747	-484
Public administration	1,231	2,145	-914	1,486	2,311	-825
Industry not reported	1,352	714	638	936	1,877	-941
Totals	47,996		11,748[a]	46,600		10,145[a]

[a]Total of positive differences.

Table 13. Proportion of six county employment within Fort Dodge 1960

Industry	1960 Area Employment	1960 Fort Dodge Employment	Proportion
Agriculture	12,308	95	0.77
Mining	108	12	11.11
Manufacturing	7,418	2,997	40.40
Transportation	1,767	445	25.18
Communication & public utilities	1,042	319	30.61
Wholesale trade	1,642	449	27.34
Retail trade	7,838	2,234	28.50
Finance, insurance & real estate	1,285	484	37.66
Services	8,507	2,680	31.50
Contract construction	2,263	425	18.78
Public administration	1,486	388	26.11
Industry not reported	936	360	38.46
Total	46,600	10,888	23.36

the proportion of the area's basic employment located in Fort Dodge is large relative to other activities. This is not surprising, however, because of the major role of agricultural products in wholesale and retail trade.

B. Shift Analysis

Table 14 summarizes the components of the 1950 to 1960 employment shifts for the Fort Dodge area by the 12 aggregate industrial categories cited earlier. The data show the effects of the three shift analysis components--national growth, regional share and industrial mix--as well as the coefficients used in calculating the latter two. The national growth coefficient, as noted in Chapter II, is the same for all industries. For the period 1950-1960 it is 14.54 percent. The respective regional share and industrial mix shift coefficients were calculated using the model presented in Chapter II. The actual effects were calculated by applying these coefficients to the 1950 employment estimates for the given industries. For example, the six county employment in agriculture in 1950 was 47,996. The national growth effect for agriculture in the Fort Dodge area is (14.54) (47,996) = 2,419. The regional share effect is (12.15) (47,996) = 2,021, and the industry mix effect is (-52.70) (47,996) = -8,767. Summing these effects gives a total shift of -4,327. The net relative shift is the sum of the regional share effect and the industry mix effect.

Before proceeding to analysis of the various categories, we shall attempt to clarify the meaning of "regional share" and "industry mix". The industry mix shift coefficient assumes the same value for a given

Table 14. Components of employment shifts, Fort Dodge area, 1950-1960

Industry	Shift coefficients		Employment effects				
	Regional Share	Industrial Mix	National Growth	Regional Share	Industry Mix	Total Shift[a]	Net Relative Shift[b]
Agriculture	12.15	-52.70	2,419	2,021	-8,767	-4,327	-6,746
Mining	29.63	-44.44	16	32	-48	0	-16
Manufacturing	25.84	4.71	743	1,321	241	2,305	1,562
Transportation	-13.19	-21.79	323	-293	-484	-454	-777
Communication & public utilities	-9,71	.32	144	-96	3	51	-93
Wholesale trade	-31.09	-1.92	293	-6266	-39	-372	-665
Retail trade	-5.86	-2.40	1,072	-432	-177	463	-609
Finance, insurance & real estate	66.79	25.83	140	-65	248	323	183
Services	-15.01	19.72	1,037	-1,071	1,407	1,373	336
Contract construction	-31.22	-4.19	416	-893	-120	-597	-1,013
Public administration	-6.67	12.84	179	-82	158	255	76
Industry not reported	-240.03	194.72	196	-3,245	2,633	-416	-612
Total			6,978	-3,429	-4,945	-1,396	-8,374

[a]Total shift equals national growth effect plus regional share effect plus industry mix effect.

[b]Relative shift is the sum of the regional share and the industrial mix effects.

industry for any region. It may be defined as the difference between the overall national growth rate and the national growth rate of a given industry. If the national rate of employment change for a given industry exceeds the total national employment growth rate, then the industry mix coefficient for that industry is positive. Employment in that industry in a given region then provides a positive contribution to net relative shift. If the total national employment growth rate is larger than the growth for that industry then the contribution of that industry is negative.

The regional share coefficient may be defined as the difference between the rate of employment change for a given industry in a given region and the nation employment growth rate for that industry. The regional share coefficient may take on a different value for each industry both within and between regions. If the regional share coefficient is positive (negative) for a given industry this means that a given region is increasing (decreasing) its proportion of national employment in that industry.

Industries in the study area may be divided into four classes according to the sign of the regional share and the industrial mix coefficients. The first classification contains those industries for which both effects are negative. Of the 12 industries listed in Table 14, four fit this classification. In the case of three--wholesale trade, retail trade and contract construction--the regional share effect is more important, while for the fourth--transportation--the industry mix effect dominates the net relative shift. It is noted that two of these industries, wholesale and retail trade, both having a negative net relative shift, are basic industries for the area.

The second category includes industries with a positive regional share effect and a negative industry mix effect. Both agriculture and mining meet these qualifications and in both cases the industry mix dominates to produce a negative net relative effect. Here again we are dealing with a basic industry, namely, agriculture.

Industries with a negative regional share effect and a positive industry mix effect make up the third classification. The category communication and public utilities has a regional share effect which is greater in absolute value than the industrial mix effect while for public administration, finance, insurance and real estate, and services the industry mix is more important, producing a positive net relative shift. We ignore "industry not reported" because of its indeterminant nature.

Only one industry falls into the final category in which both effects are positive. Regional share effect is more important in manufacturing employment change, but industry mix also contributes to a positive net relative shift of 1,562 persons, the largest for any industry in the area. The services sector also shows a sizable net relative shift. For this reason, and because both services and manufacturing contain a number of sub-categories, we shall conduct a more detailed analysis of these two aggregate industries. This will not only provide additional information about area employment, but will also facilitate a more complete evaluation of the usefulness of shift analysis.

One of the advantages of shift analysis is that it enables detailed inspection of area employment changes. Tables 15 and 16 show the aggregate categories, manufacturing and services, respectively, subdivided into their prime[1] components. It is important to note that the summations of regional share and industry mix effects of the components do not equal the regional share and industry mix effects for the aggregate classifications. As Ashby explains, "The industrial mix and regional share components, when summarized across two or more industries, depend in part upon the level of industrial detail (within a given total) under analysis. However, the changes in these two components which are induced by changes in the level of industrial detail are equal in absolute value and of opposite sign. It follows that their sum, the net relative change, is unaffected by any such changes in the level of aggregation (2, p. 17)". This can easily be seen by comparing column totals in Tables 15 and 16 with the aggregate classes.

The prime category within manufacturing which shows the greatest growth potential is food and kindred products with a net relative shift of 1,024. If we calculate its location coefficient, we find that it is 1.3321 in 1950 and 2.2376 in 1960, which qualify food and kindred products as a basic industry. Several other manufacturing sub-categories such as printing, publishing and allied, electrical machinery, transportation equipment, and other durable goods, also show growth potential. The only other class, however, with a location coefficient greater than one is "other durable goods".

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[1]A prime category refers to an industry which is not sub-divided into greater detail.

Table 15. Components of manufacturing employment shifts, Fort Dodge area, 1950 - 1960

Industry	Shift coefficients		Employment effects				
	Regional share	Industrial mix	National growth	Regional share	Industry mix	Total[a] shift	Net relative shift[b]
Food & kindred products	52.66	8.49	243	882	142	1,267	1,024
Printing, publishing, & allied	11.15	17.71	68	53	83	204	136
Chemical & allied	-45.73	21.11	58	-182	84	-40	-98
Textile mill products	31.80	-36.82	3	7	-8	2	-1
Apparel & other fabricated products	-28.17	-5.85	11	-22	-4	-15	-26
Other non-durable goods	-75.93	-8.61	38	-198	-22	-182	-220
Furniture, lumber & wood products	10.77	-25.31	16	12	-28	0	-16
Primary metal industries	167.00	-11.17	4	45	-3	46	42
Fabricated metal industries	59.39	37.93	9	35	22	66	57
Machinery, except electrical	-23.18	10.55	107	-170	77	14	-93
Electrical machinery, equipment, etc.	192.53	58.15	17	221	67	305	288
Motor vehicles & equipment	26.74	-16.28	2	4	-2	4	2
Transportation equipment	2,979.16	86.30	1	149	4	154	153
Other durable goods	14.79	12.59	167	169	144	480	313
Manufacturing[c]	25.83	4.71	743	1,321	241	2,305	1,562
Totals			744[d]	1,005	556	2,305	1,561[d]

[a]Total shift equals national growth effect plus regional share effect plus industry mix effect.

[b]Relative shift is the sum of the regional share and the industry mix effect.

[c]Not included in totals.

[d]Because of rounding error these totals do not agree exactly with the shifts of manufacturing in the aggregate.

Table 16. Components of services employment shifts, Fort Dodge area, 1950 - 1960

Industry	Shift Coefficients		Employment Effects				
	Regional Share	Industry Mix	National Growth	Regional Share	Industry Mix	Total Shift[a]	Relative Shift[b]
Business services	-110.97	98.08	26	-202	179	3	-23
Repair services	-23.57	-25.10	159	-258	-274	-373	-532
Private households	-.67	5.18	128	-6	46	168	40
Other personal services	-6.82	-10.37	154	-72	-110	-28	-182
Entertainment & recreation service	-37.53	-12.63	55	-142	-48	-135	-190
Medical & hospital	-83.05	55.56	154	-879	588	-137	291
Educational-government	-33.73	49.65	232	-539	794	487	255
Educational-private	-15.89	46.07	36	-39	113	110	74
Other professional & related services	157.78	27.68	93	1,008	177	1,278	1,185
Services[c]	-15.01	19.72	1,037	-1,071	1,407	1,373	336
Totals			1,037	-1,129	1,465	1,373	336

[a]Total shift equals national growth effect plus regional share effect plus industry mix effect.

[b]Relative shift is the sum of the regional share and the industry mix effect.

[c]Not included in totals.

The service sub-categories showing a large net relative shift are public education and other professional services. Both public education and other professional services had a location coefficient greater than one in 1960 so that may be regarded as basic industries. The repair services category also qualifies as basic; yet it has the largest negative net relative shift of any prime service category.

Growth coefficients also lend themselves well to projective techniques. Table 17 shows 1975 employment projections for 50 employment projections for 50 industrial classes. The model used for these forecasts is a modification of the model derived by Maki and Suttor (53). It is given by the equation,

$$g_i^{N/10} (e_{i_t}) = e_{i_{(t+N)}} \quad , \text{ where}$$

$$g_i = e_{i_t} / e_{i_{t-10}}, \qquad \text{and}$$

e_{i_t} = total number of persons employed in the ith industry at the most recent decennial census:

$e_{i_{(t-10)}}$ = total number of persons employed in the ith industry at the previous decennial census;

$e_{i_{(t+N)}}$ = projected employment in the ith industry;

N = length of th period of the projection in years.

The value of the projection for the detailed classes is questionable because a deviation of comparatively small magnitude tends to represent a considerable percentage of the projected figures. For this reason a further disaggregation of the basic equation may be

Table 17. Estimated employment in specified industry, Fort Dodge area, 1950, 1960, 1975

Industry[a]	Employment					
	1950		1960		1975	
Agriculture	16,635		12,308		7,833	
Agriculture		16,631		12,305		7,833
Forestry & fisheries*		4		3		2
Mining*	108		108		108	
Manufacturing	5,113		7,418		12,963	
Food & kindred prod.*		1,674		2,941		6,849
Printing & publishing & allied*		470		674		1,157
Chemical & allied*		397		357		304
Other non-durable goods		358		163		50
Textile mill prod.*		21		23		26
Apparel & other fabricated prod.*		77		63		45
Other non-durable goods*		260		78		13
Furniture, lumber, & wood prod.*	113		113		113	
Primary & fabricated metal industries	86		198		692	
Primary metal industries*		27		73		325
Fabricated metal industries*		59		125		385
Machinery, except electrical*	734		748		770	
Electrical machinery, equip., etc.*	115		420		2,931	
Other durable goods	1,166		1,804		3,472	
Motor vehicles & equip.*		16		20		28
Transportation equip., etc.*		5		159		2,851
Other durable goods*		1,145		1,625		2,747
Transportation	2,221		1,767		1,254	
Railroad & railway express*		1,137		671		304
Trucking service & warehousing*		913		892		861
Other transportation*		171		204		266

[a]Industries marked with an asterisk are prime categories.

Table 17. (Continued)

Industry[a]	Employment					
	1950		1960		1975	
Communication & public utilities	991		1,042		1,123	
Communication		459		471		490
Utilities & sanitary service		532		571		635
Wholesale trade	2,014		1,642		1,209	
Retail trade	7,375		7,838		8,588	
Food & daily products stores		1,190		1,194		1,200
Eating & drinking places		1,491		1,497		1,506
Other retail trade		4,694		5,147		5,910
Finance, insurance & real estate	962		1,285		1,984	
Services	7,134		8,507		11,078	
Business services		182		185		190
Repair services		1,093		720		385
Personal services		1,938		2,078		2,307
Private households		882		1,050		1,364
Other personal services		1,056		1,028		987
Entertainment & recreation services		379		244		126
Professional & related services		3,542		5,280		9,610
Medical & hospital		1,058		921		748
Educational: government		1,599		2,086		3,108
Educational: private		246		356		620
Other professional services		639		1,917		9,961
Contract construction	2,860		2,263		1,593	
Public administration	1,231		1,486		1,971	
Industry not reported	1,352		936		536	
Total	47,996		46,600		50,240	

needed so that only the uniquely estimated component of the regional share coefficient is projected instead of employment. Employment can then be derived using this component.

The basic shift analysis equation is:

$$A + B + C = (\Delta e_i / e_{i_t}) \tag{38}$$

where,

$A = (\Delta E. / E._t)$, or the national growth coefficient;

$B = (\Delta E_i / E_{i_t}) - (\Delta E. / E._t)$, or the industry mix coefficient; and

$C = (\Delta e_i / e_{i_t}) - (\Delta E_i / E_{i_t})$, or the regional share coefficient.

Both A and B may be computed from given projections for the nation. C must be uniquely derived for each region. Now,

$$(\Delta E_i / E_{i_t}) = A + B = G_i \tag{39}$$

and

$$(\Delta e_i / e_{i_t}) = G_i + C = g_i^* . \tag{40}$$

The only element we need to project is C in order to derive e_i, since both A and B are given national projections, as denoted by the equations;

$$A = G., \tag{41}$$

$$B = G_i - A, \tag{42}$$

and

$$C = g_i^* - G_i \tag{43}$$

Therefore,

$$\Delta e_i = e_{i_t} (G. + (G_i - G.) + (g_i^* - G_i)). \tag{44}$$

If we were to project g_i^*, we would be projecting the right hand side of Equation 38, simply because the equation is definitional in form. Operationally, therefore, we must project the regional share coefficient, C, which is the difference in growth between the region and the nation for a specific industry. Employment forecasts derived from the projections of this coefficient may be more reliable than those derived from the method which we used. The explanation for this increase in reliability is that while C may show a considerable percentage fluctuation, the effect of this fluctuation on absolute employment figures will be small since C is only a portion of total employment change. The important consideration is to attempt to discover a general trend for C tending toward an upper or lower limit or zero.

In concluding this chapter we shall use the $g_i = (e_{i_t}/e_{i_{t-10}})$ derived for the projection model as a basis for an employment growth trend index; this will enable us to look at the overall growth trends for the aggregate industrial classes and national growth. The index is simply g_i 100 and is plotted in Figure 13. As would be expected, the only industries showing a greater employment growth rate than the national rate are those that show a positive net relative shift in Table 14.

The rapid decline in agricultural employment change also is not surprising.

In summary, this chapter covers information regarding employment changes in the study area. We have found that there are only three broad classes of basic industry in the Fort Dodge area, none of which

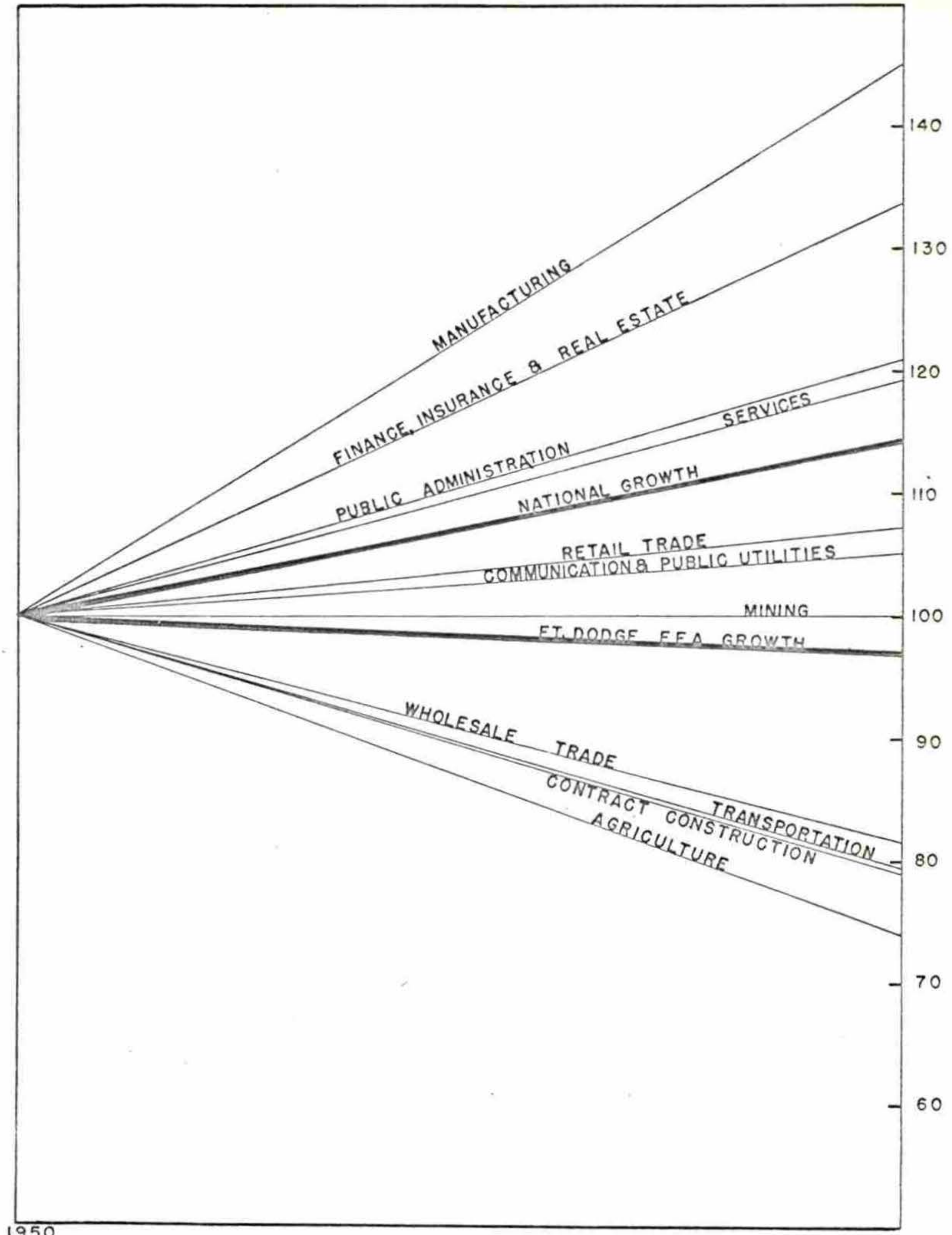

Figure 13. Fort Dodge area employment growth index by industry, 1950-1960

show a great deal of growth potential. The basic service ratio is decreasing, and thus, the employment multiplier is increasing. Those aggregate industrial classes showing the greatest promise in terms of employment growth are manufacturing; finance, insurance and real estate; public administration; and services. Employment projections show that these categories will contain the greatest proportion of 1975 employment. A more detailed analysis has revealed that within these aggregate categories certain prime industries which are basic to the area and also show considerable employment growth potential.

The meaning and implications of this information is discussed in Chapter VI and VII.

V. SPATIAL DISTRIBUTION AND MOBILITY

In the two previous chapters our primary concern has been with the static location and temporal movement of population and employment. This chapter is concerned with the analysis of the spatial mobility of households and workers. The analysis involves three major considerations, namely, migration trends, commuting patterns and consumption patterns.

The analysis of migration trends is concentrated specifically upon the Fort Dodge area with additional reference to studies conducted in the Upper Midwest[1] (1) and the Northern Plains[2] (56). The study of commuting also centers upon the Fort Dodge area. Again, supplementary information from Upper Midwest Studies (1, 16) proves useful.

Consumer purchase patterns are analyzed in terms of a 1960 "Business Impact" survey. This survey sample was of a stratified cluster type drawn randomly from the population of Iowa open-country farms and households. Survey information was obtained on all purchases made by a sample of 497 farms, 486 farm households, and 115 open-country households for a period of 1 year. The term open-country refers to the area outside the limits of incorporated towns and cities[3]. An Upper Midwest study also provides additional trading pattern information(15).

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[1]The "Upper Midwest" includes Minnesota, Montana, Northern Michigan and Wisconsin, and North and South Dakota.

[2]The Northern Plains include Iowa, Nebraska, Minnesota, and North and South Dakota.

[3]Baker, Harold, Iowa State University, Ames, Iowa. Sampling definition. Private Communication. 1965.

A. Migration

Residential movements within or between regions may improve real income and employment opportunities (1, 40, 63, 64, 87). It is possible, however, that friends and relatives, rather than economic opportunity, is the most important factor affecting population migration (60). Friends and relatives provide essential information about jobs and living conditions, which makes migration feasible.

Table 18 shows net migration (i.e., the difference between potential population, based on natural increase, and actual population) from the six county area and also from Fort Dodge during the 20 year period from 1940 to 1960. To the extent that migration trends reveal basic economic prospects for an area, the data in Table 18 suggest continuation in total population decline for the Fort Dodge area. Out migration increased from 12.1 percent during the 1940-1950 period to 13.1 percent from 1950-1960. Fort Dodge shows an out migration of 5.9 percent during the 1950 to 1960 period. This represents an increase of 2.7 percent over the 1940 to 1950 period. Table 19 compares net migration for the six county area, Fort Dodge, and the State.

The migration data show that the Fort Dodge area is losing a considerable number of employable people in the 25-64 age group. This suggests a lack of adequate job opportunities in the area and in Fort Dodge. The results of the Northern Plains study (56) support these findings. That area is also an agriculturally based region with substantial out-migration (Table 20). Again, the highest rate of out migration occurs among young adults ranging in age from 20 to 34.

Table 18. Net migration, Fort Dodge and six county area, 1940 to 1950 and 1950 to 1960[a]

County and city	Pop. 1950[b]	Natural increase	Potential Pop. 1960[b]	Actual Pop. 1960[b]	Net migration 1950 to 1960		Net migration 1940 to 1950	
					Number	% of 1950 pop.	Number	% of 1940 pop.
Fort Dodge[c]	25,115	4,754	29,869	28,399	-1,470	-5.9	-743	-3.2
Calhoun	16,925	1,874	18,799	15,923	-2,876	-17.0	-2,663	-15.1
Hamilton	19,660	2,462	22,122	20,032	-2,090	-10.6	-2,660	-13.4
Humboldt	13,117	1,853	14,970	13,156	-1,814	-13.8	-2,046	-15.2
Pocahontas	15,496	2,243	17,739	14,234	-3,505	-22.6	-2,914	-17.9
Webster	44,241	7,394	51,635	47,810	-3,825	-8.6	-2,490	-6.0
Wright	19,652	2,588	22,240	19,447	-2,793	-14.2	-2,871	-14.3
Total	129,091	18,414	147,505	130,602	-16,903	-13.1	-15,644	-12.1

[a]Source: Wakely (85).

[b]Population as of April 1st.

[c]Not included in totals.

Table 19. Net migration, Iowa, Fort Dodge and six county area, 1940 to 1950 and 1950 to 1960[a]

State, area and city	Pop. 1950[b]	Natural increase	Potential Pop. 1960[b]	Actual Pop. 1960[b]	Net migration 1950 to 1960		Net migration 1940 to 1950	
					Number	% of 1950 pop.	Number	% of 1940 pop.
State	2,621,073	365,071	2,986,144	2,757,537	-228,607	-8.7	-197,945	-7.8
Area	129,091	18,414	147,505	130,602	-16,903	-13.1	-15,644	-12.1
Fort Dodge	25,115	4,754	29,869	28,399	-1,470	-5.9	-743	-3.2

[a]Source: Wakely (75).

[b]Population as of April 1st.

Table 20. Rank order of out-migration rates by age groups in the northern Plains[a]

Age Group	Out-Migration Rate %	Rank
20-24	43.3	1
25-29	31.4	2
30-34	22.9	3
15-19	20.9	4
5-9	18.2	5
35-39	17.4	6
10-14	14.0	7
40-44	12.8	8
45-54	9.7	9
55-64	7.3	10
65 & over	6.9	11

[a]Source: (50).

Only 96 percent of the region's out migration came from non-metropolitan areas, while over 95 percent of the migrants went to metropolitan areas.

The findings of the Upper Midwest migration study (1) also support the findings for the Fort Dodge area and the Northern Plains. Again, each of the three areas have a largely agriculturally based economy. With reference to the Upper Midwest region, however, six urban centers attracted 43 percent of total area in-migration. Such growth centers attracted 15 to 20 percent of their migrants from surrounding counties and 40 to 50 percent from the rest of the region. These centers are characterized by growth in new job opportunities, high population turnover, good housing, and above average income and education advantages. The contrasting results for the Fort Dodge area suggest that, though Fort Dodge is an urban area, it lacks some of these characteristics.

B. Commuting Patterns

Largely because of highway construction and the widening and resurfacing of existing roads, commuting has become a substitute for migration as a means of obtaining improved job opportunities. Referring again to the results of the Upper Midwest migration study (56), commuting is most prevalent in areas around growing non-metropolitan cities in agricultural regions with surplus labor, and in areas of dispersed, partly agricultural settlements. Small towns with available housing, cheap space, and a mobile population (i.e., a population willing to commute) may survive and even grow if they are within, say, 50 miles of a thriving urban growth center and are located on a good highway.

We look now at Iowa commuting patterns. Figure 14 displays commuting patterns around the focal center counties of the 15 Iowa FEA's for 1960[4]. The black dots are proportional in area to the number of commutors living in the county where the dot is located, commuting to the focal center the arrow indicates. Note that there is a positive relationship between the size of the focal center and the labor supply area. Also, in the case of Dubuque, Davenport, and Sioux City areas, some commutation originates in counties outside Iowa.

Turning specifically to the Fort Dodge area, Figure 15 shows the magnitude of commutation to and from each of the six counties in 1960. For Webster county, for example, total number working in the county is 17,073. Of this number, 856, or 5 percent, are commutors. Pocahontas county also has a labor force of which 5 percent are commutors, while Hamilton has 3.8 percent, Wright 4.4 percent, Humboldt 3.7 percent and Calhoun 3.6 percent. The presence of Fort Dodge appears to have very little effect on the percentage commuting to Webster County, which contradicts that expectation of a positive correlation between commuting and city size, (assuming that the city possessed the characteristics of a thriving growth center).

Figure 16 shows a more detailed representation of Fort Dodge area commuting patterns. This figure shows the relation of the six counties in this Fort Dodge area to the diamond-shaped delineation

[4]The data for this figure were derived from unpublished 1960 U.S. census data.

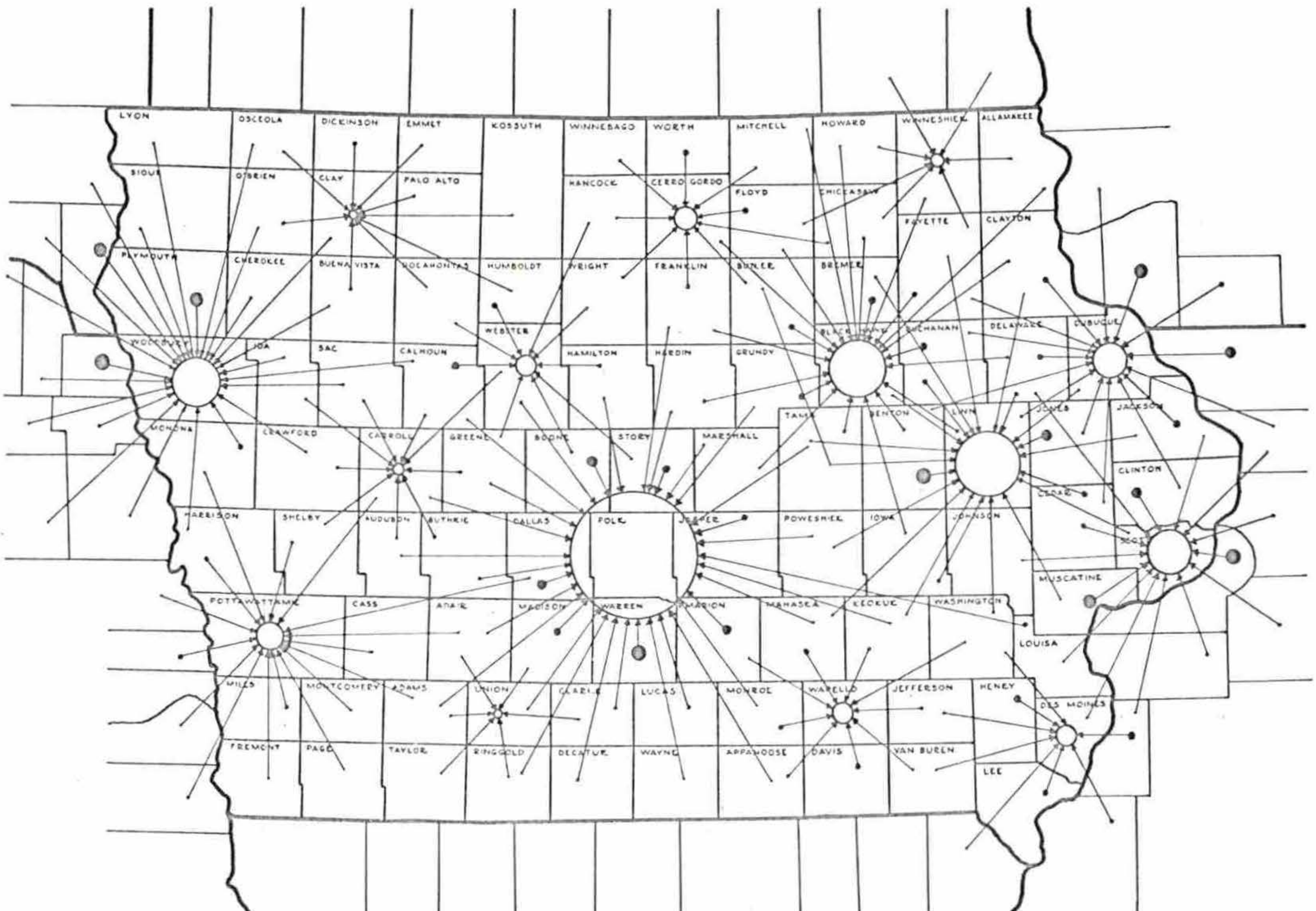
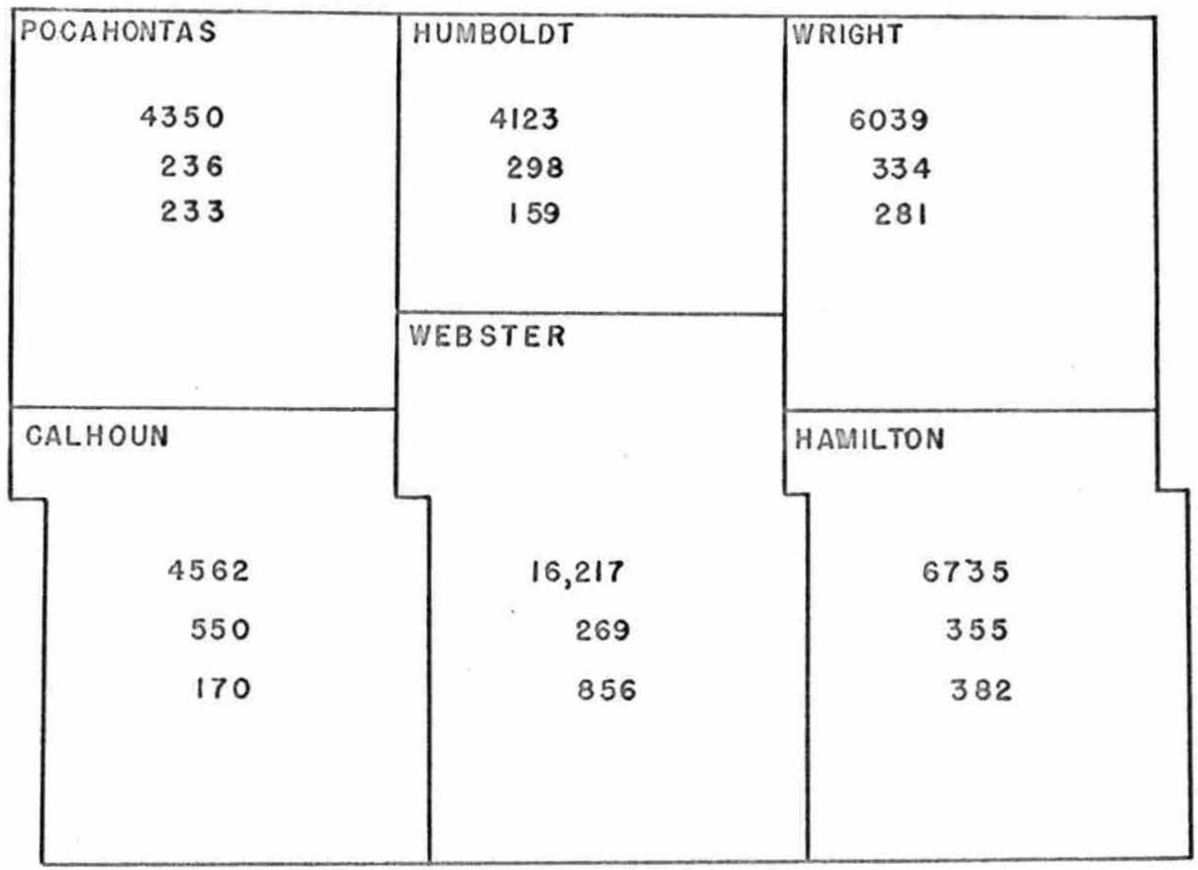


Figure 14. Commuting patterns to focal center counties



TOP— LIVING & WORKING IN COUNTY
CENTER — LIVING BUT NOT WORKING IN COUNTY
BOTTOM — WORKING BUT NOT LIVING IN COUNTY

Figure 15. Fort Dodge area commutation by county

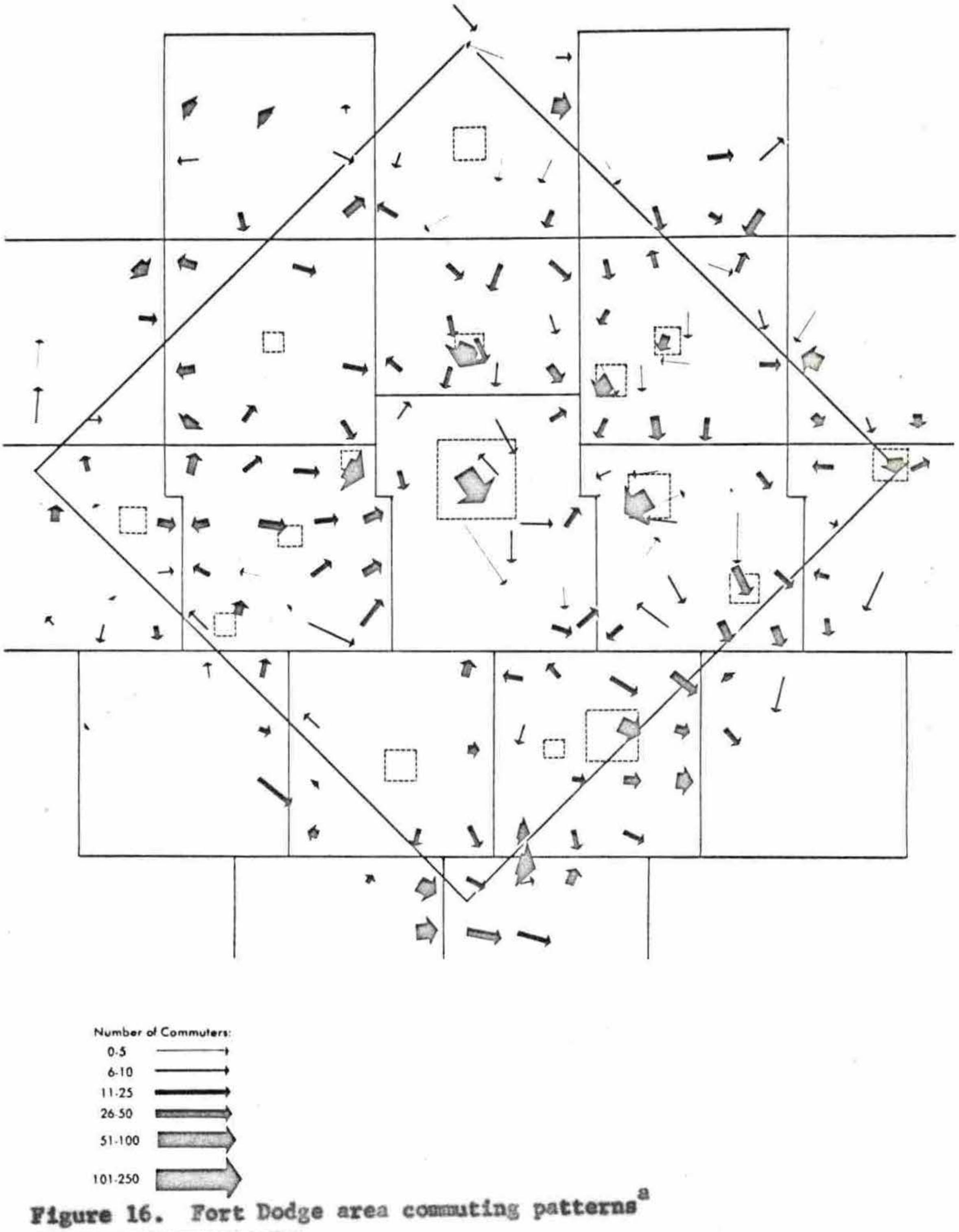


Figure 16. Fort Dodge area commuting patterns[a]

[a]Source: Fox and Kumar (34).

counties in this Fort Dodge area to the diamond-shaped delineation used by Fox (30). The width of the arrows represents magnitude, the length represents distance, and the direction represents a vector sum. These arrows again show the dispersed pattern of commutation.

C. Consumer Trade Patterns

The Business Impact study previously described was a joint undertaking of members of the State University of Iowa and Iowa State University under the auspices of the Research Committee of the Iowa College-Community Research Center. The first results presented are the findings of the University of Iowa under the direction of Dr. Arthur Welsh[5]. The second part of the analysis involves a different approach to the same data, and our findings.

In this section we are not concerned with the population of cities but with the consumption patterns of open-country households and farms. It is the effect of these purchase patterns on the central city which we wish to assess. We also wish to present some techniques for this type of investigation.

1. State University of Iowa results

The analysis of consumption patterns conducted by the Bureau of Business and Economic Research was based on a "linkage" classification of 32 goods and services purchased by 486 farms and 115 open-country households. This "linkage" analysis involves the grouping or linking

[5]Welsh, Arthur, Bureau of Business and Economic Research, State University of Iowa, Iowa City, Iowa. Unpublished study. Private Communication. 1965.

together of those goods and services which have a high probability of being purchased in the same type or size of town. The six groupings used appear in Table 21. They are ranked according to "order" with the lowest "order" goods listed in Group I and the highest "order" in Group VI. "Order" is assumed to represent the consumer's willingness to "shop around" before purchasing an item. The lowest order commodities involve the least shopping, the commodities in Group VI the most. Table 22 also displays the mean distance traveled to, and mean population of, the town of maximum purchase for each item. The correlation coefficient for these two means is 0.8629.

Although a large part of this correlation may occur because the number of large towns in Iowa is small, and it is, on the average, necessary to travel a greater distance to them than to smaller towns, the important consideration is the pattern of relationships for specific consumer items. Consumers are willing to and, in fact, do travel farther to larger towns to obtain certain commodities.

Figure 17 and 18 present this phenomenon spatially on maps of the Fort Dodge area. Trade areas for low order goods based on survey data appear in Figure 17. The low-order goods represented are those from Groups I and II, Table 21. The high order goods are Groups V and VI. Note the considerable increase in area size and the decrease in number of areas for high order goods (Figure 18).

The truncated nature of the high order shopping areas between Fort Dodge and Webster City is probably the result of competition for this type of goods between the two towns.

Table 21. Linkage classification

Group I

- Beauty & barber
- Car, running costs
- Food locker
- Food
- Fuel, house
- Gifts, organizational
- Repairs, TV & appliance

Group II

- Dry cleaning
- Food & drink away
- Hobby equipment
- Medicines, not prescribed
- Medicines, prescribed
- Personal care items
- Repairs, house
- Shoe repair

Group III

- Dentist
- Glassware & silver
- Major appliance
- Physician & chiropractor
- Sporting goods

Group IV

- Clothing, men's
- Movies
- Pets and pet care

Group V

- Car purchase
- Clothing, boys
- Clothing, gifts
- Furniture
- Minor appliances
- Textiles
- Toys

Group VI

- Clothing, girls
- Clothing, women's

Table 22. Selected characteristics of commodities (Mean values)

Item	Town of Maximum Purchase		
	Mean distance (miles)	Mean population (1,000)	Mean value of purchases (dollars)
Food & drink away	10.7	1.8	126
Personal care items	10.7	1.4	30
Clothing, men's	15.6	2.5	110
Clothing, women's	30.3	10.6	101
Clothing, boys	15.6	2.3	128
Clothing, girls	29.3	6.8	123
Clothing, gifts	17.7	3.3	48
Major appliances	14.5	4.6	290
Minor appliances	26.0	12.5	75
Furniture	18.7	3.2	142
Textiles	20.5	3.5	22
Glassware & silver	14.6	1.7	11
Fuel, house	7.8	0.7	198
Repairs, house	12.2	1.7	179
Physician & chiropractor	13.6	1.5	100
Dentist	11.1	1.2	60
Medicines, prescribed	11.5	1.7	53
Medicines, not prescribed	9.2	1.0	15
Movies	16.7	4.2	14
Sporting goods	14.1	1.5	17
Hobby equipment	13.3	1.9	20
Toys	15.0	2.6	48
Pets & pet care	13.4	1.3	5
Car, running costs	7.2	0.7	245
Gifts, organizational	9.3	1.1	17
Beauty & barber	7.4	0.7	44
Dry cleaning	10.6	1.1	21
Shoe repair	9.5	1.0	6
Food locker	9.9	1.9	32
Repairs, TV & appliance	7.9	0.7	27
Car purchase	19.7	2.2	1,221
Food	7.8	0.9	848

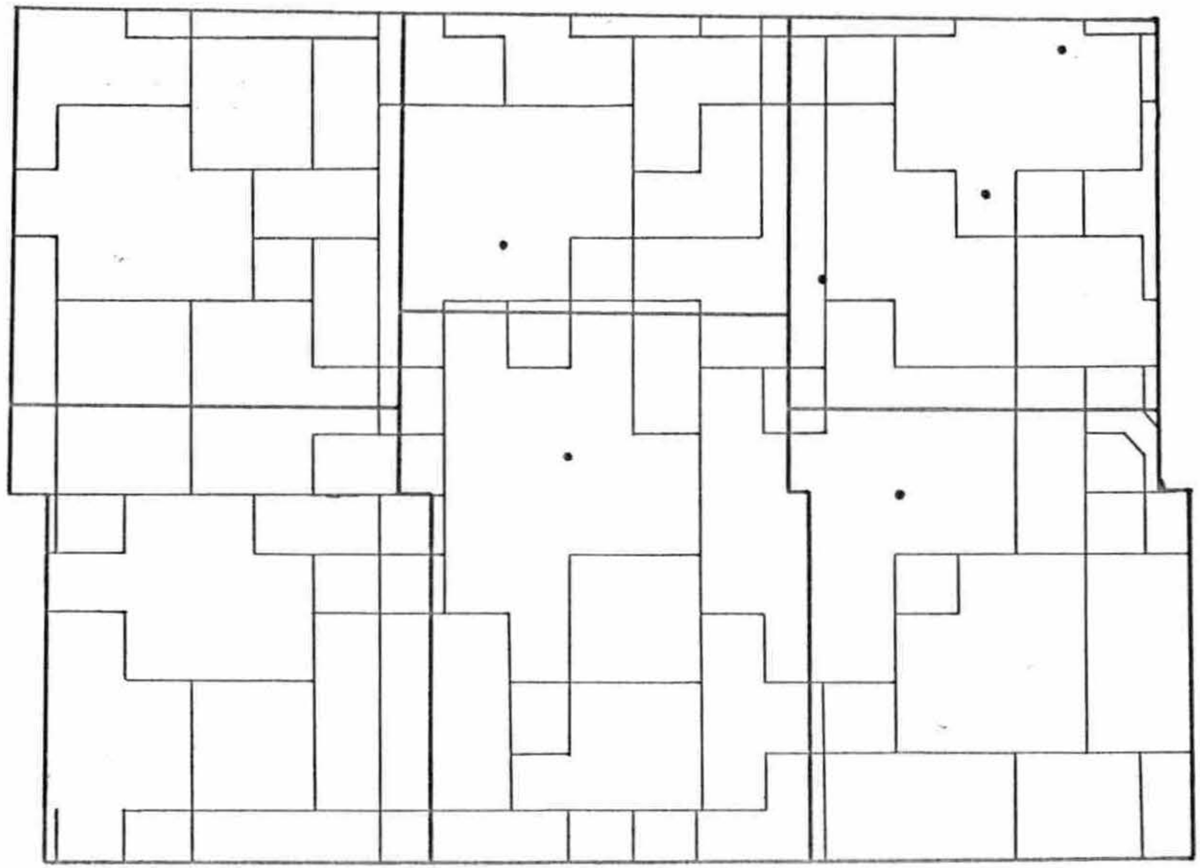


Figure 17. Low-order goods shopping areas for six county Fort Dodge area

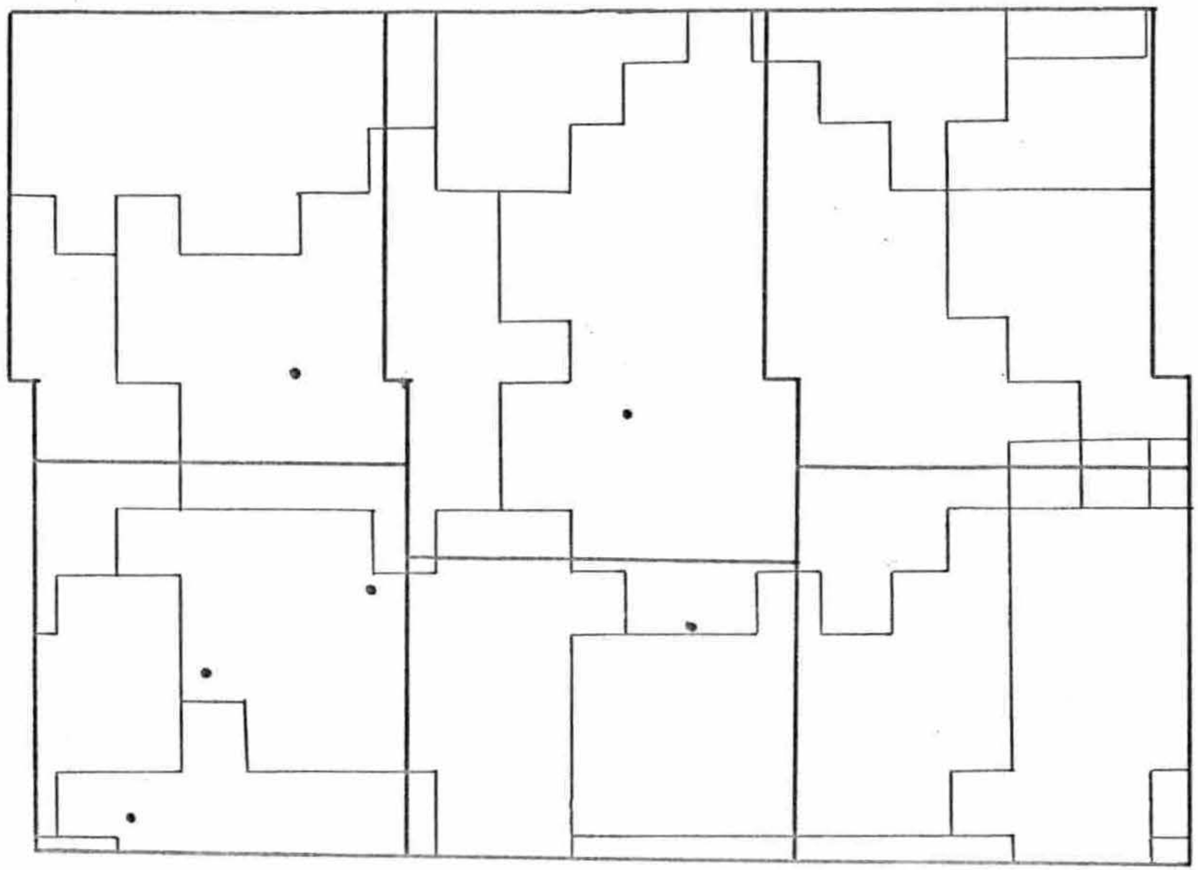


Figure 18. High-order goods shopping areas for six county Fort Dodge area

The purchase patterns for women's clothing were analyzed further, inasmuch as this category shows the largest mean distance to the town of maximum purchase in Table 22. These purchase patterns are represented by arrows on Figure 19. Note the concentration on Des Moines and other large cities. The tendency of consumers to travel greater distances to purchase certain items in larger cities suggests a continuing decline in retail sales in many small towns. This will be particularly true as new highways are built and the old ones improved making large cities more accessible.

2. Iowa State University results

The analysis of the relationship between distance traveled and city size for the purchase of various goods is confined to only a few items, inasmuch as these results are similar to those cited earlier. However, the detailed analysis are presented with reference to four alternative techniques for analysing these data. We shall look at two purchase items of widely differing value from each of the three classes of expenditure, open-country households, farm households, and farm business expenditures.

For this analysis all Iowa towns, incorporated and unincorporated are considered as possible trade centers. The 1960 distribution of these towns by size class, both by number and population, appears in Table 23. The percentage in each size class is also shown.

The first technique which we will employ is "number based", that is, we shall assume that the proportion of total expenditure of farm households for a given item spent in towns within a given size class

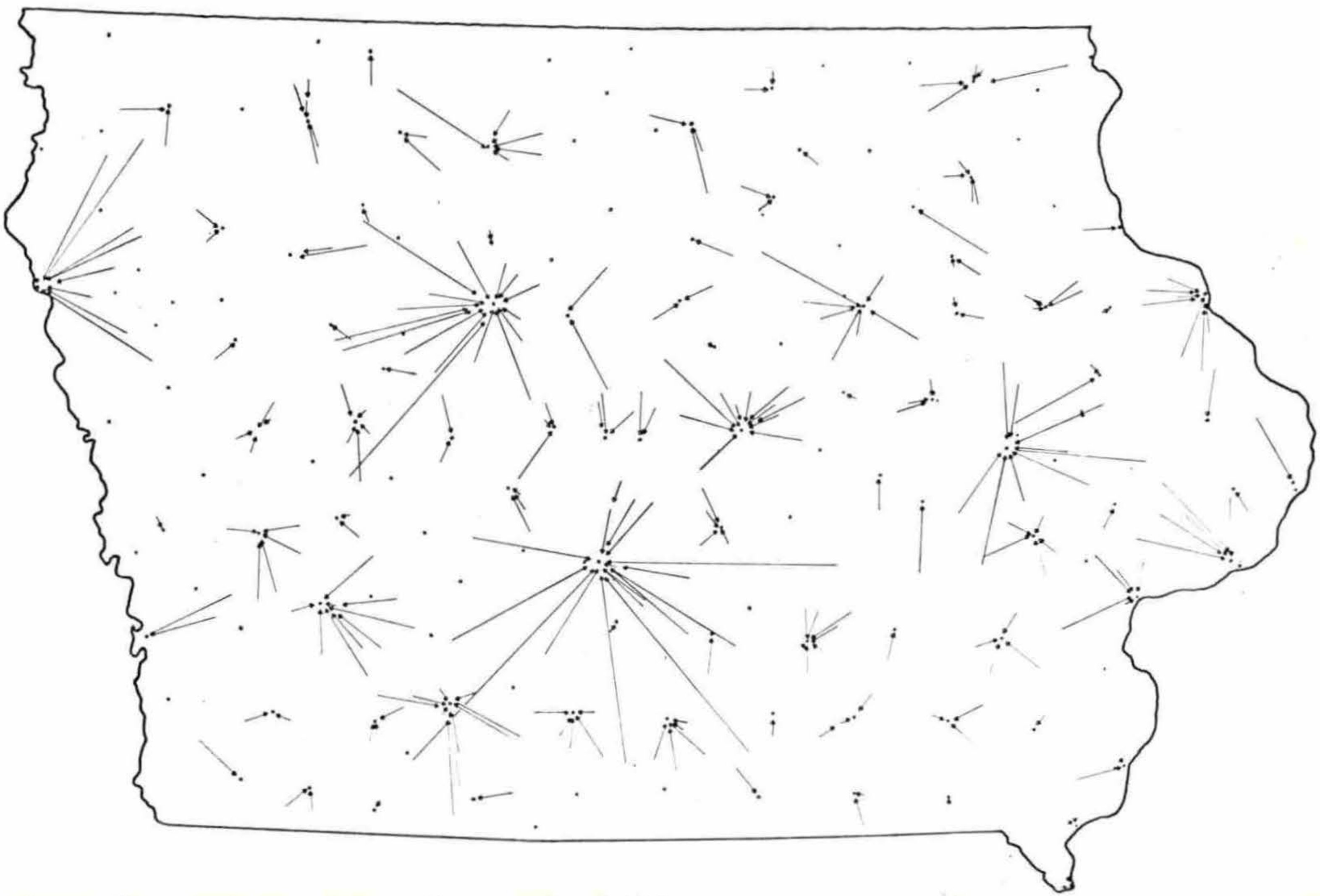


Figure 19. Purchase patterns for women's clothing

Table 23. Number and percentage distribution of Iowa trade centers by size class, 1960

Item	Population size class										
	0 to 199	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up	Total
No. of towns	794	330	220	78	58	46	33	11	13	1	1584
Percentage	50.1	20.8	13.9	4.9	3.7	2.9	2.1	0.7	0.8	0.1	100.0
Population	101,632	105,600	152,680	94,614	110,606	161,368	227,073	169,543	673,556	208,982	2,005,654
Percentage	5.1	5.3	7.6	4.7	5.5	8.0	11.3	8.5	33.6	10.4	100.0

is equal to the proportion of the total number of towns in that class. Thus, we are assuming that every town, regardless of size, has an equal-size trade area. We are assuming throughout the discussions that farm and open-country population, and also towns, are homogeneously distributed throughout the state, and that the population of all towns is point centered.

Table 24 shows the expected proportion of expenditures per town size class using the number-based assumption; the table also shows the actual proportion of food and household furnishing expenditure for farm households obtained from the survey. We have calculated the differences between the expected and the actual percentages and these also appear in Table 24. Examining this table we note first that the conformance of our assumption to reality is considerably less than desirable. While we would not expect the actual data to correspond exactly, the deviation between assumed proportion of purchase and the actual are too large to consider reasonable. Consumers do drive greater distances in order to shop in larger towns and they drive farther for household furnishings than for food. In towns of less than 1,000 population, the percentage of total furnishings purchases per class is less than the proportion of towns per class, while the same is true for food items purchased in towns under 500 population. One factor which this approach fails to show is that few towns under 200 contain an establishment selling household furnishings and many would not have a store carrying a full line of foods.

Farm people are willing to drive to larger cities (i.e., cities of more than 10,000 population) to purchase furnishings. Looking at

Table 24. Expected proportion[a] of expenditures per size class vs. actual proportion of expenditures[b] per size class

Item	0 to 199	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up
Total no. of towns	794	330	220	78	58	46	33	11	13	1
Expected proportion	50.1	20.8	13.9	4.9	3.7	2.9	2.1	0.7	0.8	0.1
Proportion of food purchases	3.8	7.1	14.0	9.1	13.0	19.9	18.5	6.3	7.3	0.7
Difference in proportions	-46.3	-13.7	0.1	4.2	9.3	17.0	16.4	5.6	6.5	0.6
Proportion of furnishings	2.2	4.0	7.3	6.3	5.6	14.0	18.7	8.6	23.8	7.4
Difference in proportions	-47.9	-16.8	-6.6	1.2	1.9	11.1	16.6	7.9	23.0	7.3

[a]Expected proportion is equal to the proportion of the total number of trade centers within a given size class (i.e. the expenditure assumption is number based).

[b]The expenditures are those made by farm households.

actual percentages, 39.8 percent of furnishings purchases are made in 1.6 percent of the towns. The largest proportion of food purchases, however, takes place in towns from 5,000 to 10,000 population, with 51.4 percent of total purchases in 8.7 percent of the towns. The results of our analysis suggest that distance is a less important purchase-determining factor for furnishings. There may be a disutility connected with city shopping which causes cities of over 10,000 population to lose some attraction in the case of food purchases.

The second analytical approach is similar to the first except that the basic assumption is exactly the opposite. This approach is population based. We assume that expenditures are proportional to city size. The expected expenditure per size class is equal to the proportion of total population living in cities and towns which falls in that class. We would not expect distance to be a factor in determining the town of purchase under this assumption.

The expected population-based proportions appear in Table 25. The actual proportion of expenditure per class are the same as before. We do, of course, have new differences between expected and actual proportions. A quick glance shows that the new assumption is more realistic for furnishings inasmuch as the differences are considerably smaller.

The negative differences in the two larger town classes may be caused by the disutility of distances, even in the purchase of expensive shopping items. This effect is even more evident in food purchase. A disutility associated with shopping in large cities may also contribute to a proportion of purchases which is less than the

Table 25. Expected proportion[a] of expenditures per size class vs. actual proportion of expenditures[b] per size class

Item	Trade center size class 0 to 199	200 to 499	500 to 999	1,000 to 1,499	1,500 to 2,499	2,500 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 to 99,999	100,000 and up
Total population	101,632	105,600	152,680	94,614	110,606	161,368	227,073	169,543	673,556	208,982
Expected proportion	5.1	5.3	7.6	4.7	5.5	8.0	11.3	8.5	33.6	10.4
Proportion of food purchases	3.8	7.1	14.0	9.1	13.0	19.9	18.5	6.3	7.3	0.7
Difference in proportions	-1.3	1.8	6.4	4.4	7.5	11.9	7.2	-2.2	-26.3	-9.7
Proportion of furnishings	2.2	4.0	7.3	6.3	5.6	14.0	18.7	8.6	23.8	7.4
Difference in proportions	-2.9	-1.3	-0.3	1.6	0.1	6.0	7.4	0.1	-9.2	-3.0

[a]Expected proportion is equal to the proportion of total trade center population living in a given size class (i.e. the expenditure assumption is population based).

[b]The expenditures are those made by farm households.

proportion of population in the larger size classes.

The negative values in the smaller classes can be explained by lack of such establishments in small towns.

Most of the results obtained from these two approaches are similar. However, by comparing the results, a more complete picture of the effect on purchases of town size and distance is obtained. The differences in proportion obtained from the two techniques are graphed in Figure 20. Comparing the two assumptions for various sections of the graph we note one additional point. The number-based assumption produces less variance for towns between 500 and 1,000 population and also for those greater than 10,000 population.

Figure 21 shows the differences from expected proportions under the two assumptions for the food and furnishings purchases of the 115 open-country non-farm Iowa households. Because of the small size of this sample, we must be extremely careful about the conclusions drawn from this graph. However, the trend lines follow much the same pattern as for farm household purchases. Some of the greater fluctuations may be attributed to sample size.

The differences between expected and actual food purchases shift from negative to positive under the population based assumption for towns greater than 1,000 population. The same phenomenon occurs for towns of 500 population or greater for farm families. The proportion of food expenditures becomes less than the proportion of population per size class (i.e., the differences change from positive back to negative) for farm families in a smaller town class than for open-country non-farm families. These results support the hypothesis that

Figure 20. Deviations from expected proportion of expenditure[a] per trade center size class, farm households expenditures

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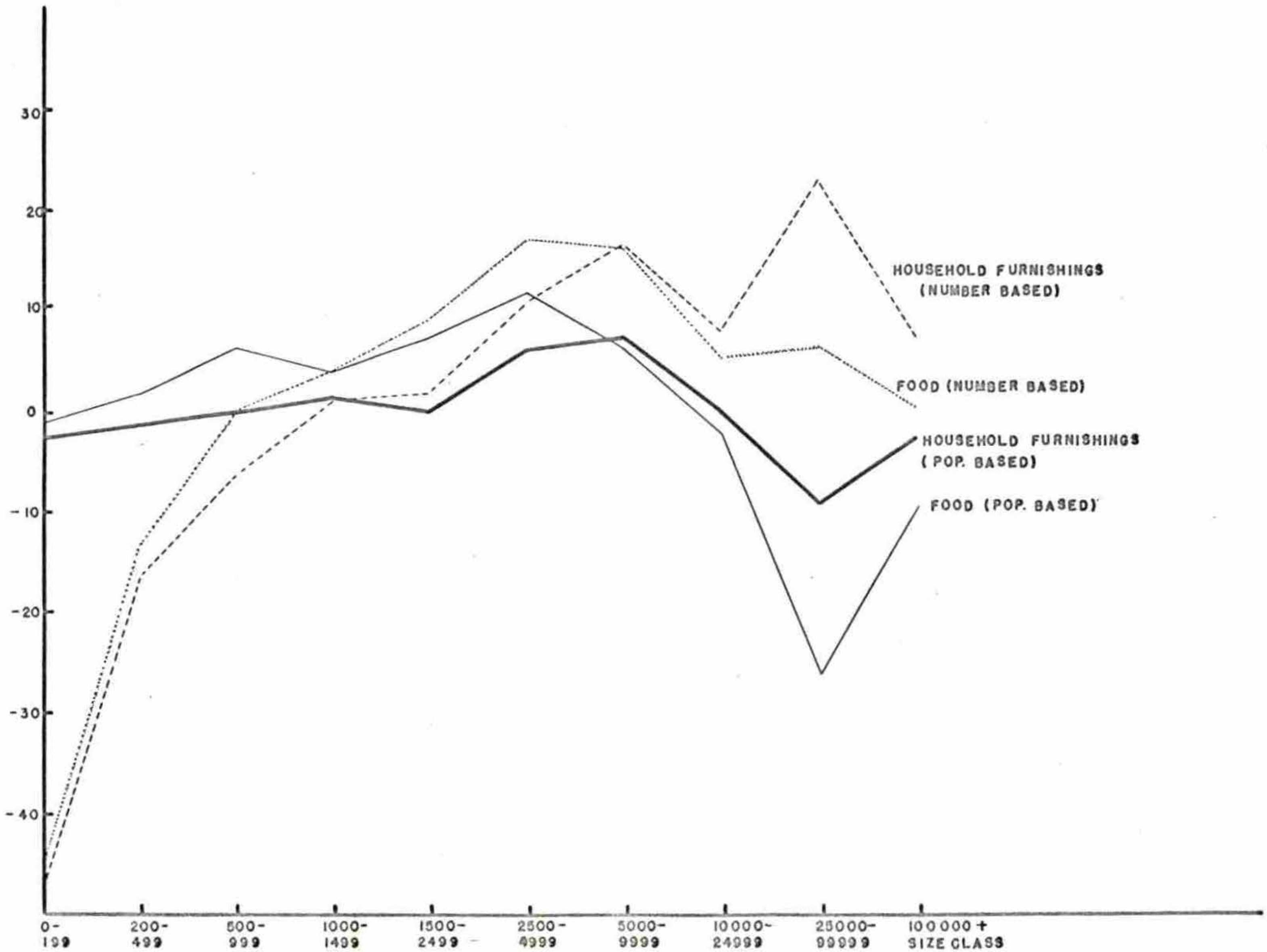
[a]Actual proportion of expenditure equal to expected proportion is a zero deviation.


30
20
10
0
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-20
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199
200-
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1499
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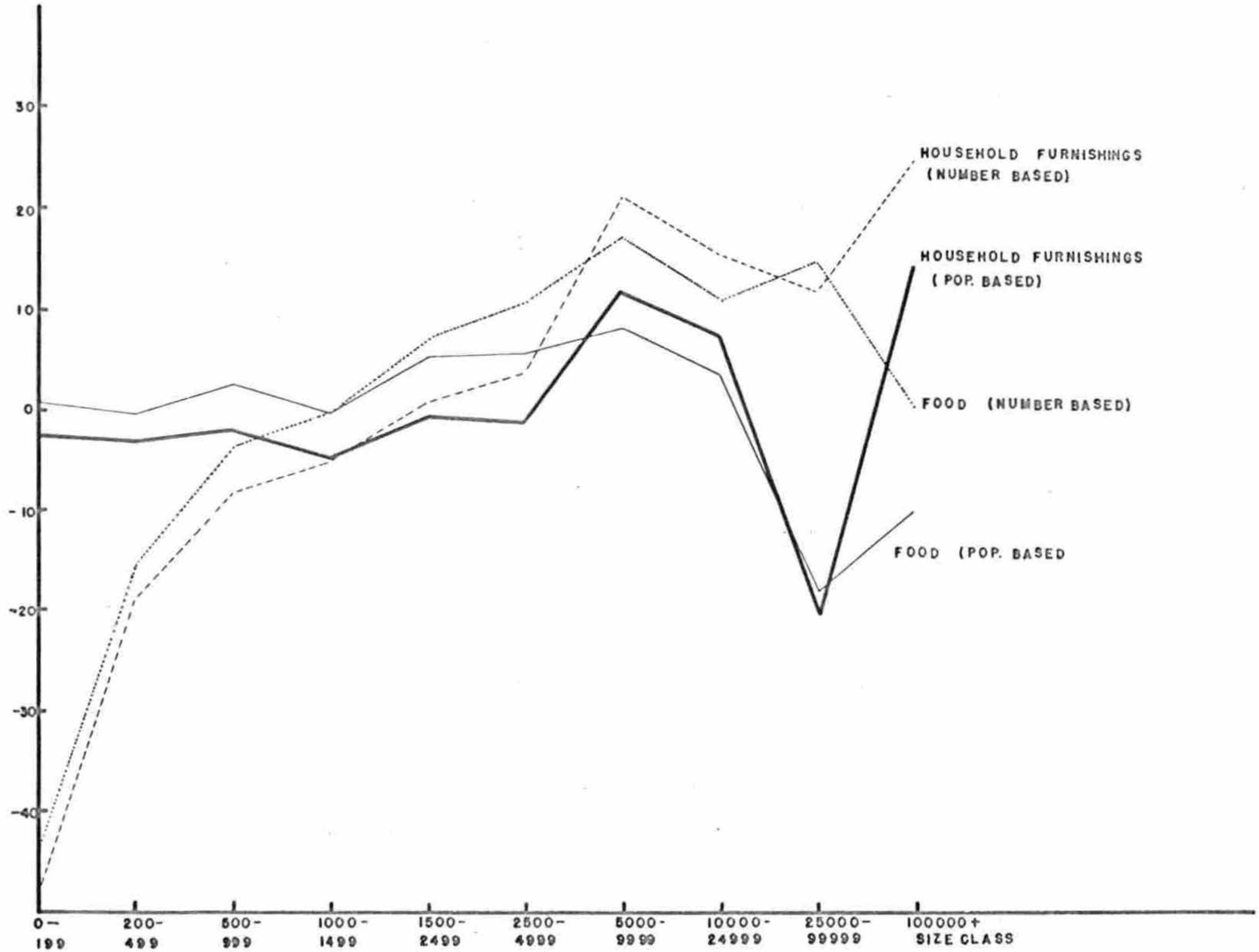
2500-
4999
5000-
9999
10000-
24999
25000-
99999
100000 +
SIZE CLASS
HOUSEHOLD FURNISHINGS
(NUMBER BASED)
FOOD (NUMBER BASED)
HOUSEHOLD FURNISHINGS
(POP. BASED)
FOOD (POP. BASED)

Figure 21. Deviations from expected proportion of expenditure[a] per trade center size class, non-farm open-country household expenditures

[a]Actual proportion of expenditure equal to expected proportion is a zero deviation.



30
20
10
0
-10
-20
-30
-40
HOUSEHOLD FURNISHINGS (NUMBER BASED)
HOUSEHOLD FURNISHINGS (POP. BASED)
FOOD (NUMBER BASED)
FOOD (POP. BASED
0–199
200-499
500-999
1000-1499
1500-2499
2500-4999
5000-9999
10000-24999
25000-99999
100000+
SIZE CLASS

members of open-country households prefer to drive further to shop in larger towns. The number-based assumption provides the same information about purchases from smaller towns. There are consistent positive differences from both assumptions for both items in towns of 5,000 to 25,000 population for open-country non-farm households. This may indicate the size town in which these people prefer to shop. Similarly, the farm household results suggest a preference for towns of 2,500 to 10,000 population.

The farm expenses selected for analysis were truck expense and motor, tools, and so on. The per unit cost of these two items does not differ as greatly as, say, tractor purchases and motor, tools, and so on. Truck expense was selected rather than an item involving more money because it has enabled us to test an additional hypothesis. Stafford (75) has suggested that improved highways are a major factor causing small towns to shrink. Paradoxically, these small towns provide much of the maintanance and repair of the vehicles traveling on these roads. This service keeps these towns from disappearing completely.

With reference to truck expense note that the actual proportion of total expenditure which takes place in the smaller towns under the population-based assumption exceeds the expected proportion considerably (Figure 22). Roughly 40 percent more of total truck expense than expected takes place in towns of 200 to 1,500 population. Under the same assumption, an excess of approximately 30 percent of total motor and tools expenditures is found in towns of 2,500 to 10,000 population.

Figure 22. Deviations from expected proportion of expenditure[a] per trade center size class, farm expenditures

[a]Actual proportion of expenditure equal to expected proportion is a zero deviation.

30
20
10
0
-10
-20
-30
-40
TRUCK EXPENSE
(NUMBER BASED)
MOTORS, TOOLS, MISC.
(NUMBER BASED)
TRUCK EXPENSE (POP. BASED)
MOTORS, TOOLS, MISC. (POP. BASED)
0-
199
200-
499
500-
999
1000-
1499
1500-
2499
2500-
4999
5000-
9999
10000-
24999
25000-
99999
100000+
SIZE CLASS

The number-based assumption more closely corresponds to actual expenditures for both truck and motor and tool expenditures in towns larger than 10,000. Expenditures occurring in towns of 1,500 to 10,000 population exceed the expectation of both assumption.

In summary, the two similar approaches thus far considered have shown that:

(1) Consumers tend to purchase furnishings in larger towns than food.

(2) Open-country households purchase the same items as farm households in larger towns.

(3) Farmers' truck and tool expenditures take place primarily in towns of less than 10,000 population.

The techniques just considered have concentrated primarily on the town in which purchases were made. The next two techniques will consider the mean distance traveled to make these purchases. Again, we will compare actual values with expected values based on some extreme assumptions. The expected mean distances for various size trade areas, depending on the assumption, were calculated using the rule developed by French (35). This, assumes diamond-shaped trade areas. The rule is:

$$\bar{D} = 2/3\ r, \qquad (45)$$

where $\bar{D}$ is mean distance traveled to the trade center and r is the distance from the trade center to one of the points of the diamond.

At one extreme we assume equal size trade areas for every Iowa town. This divides the state into 1,584 areas with a mean distance of 2.81 miles to each trade center for a uniformly distributed population. This assumption is represented by a straight line in Figure 23. As the other extreme, an overlapping of trade areas is assumed. Each town size class has the whole state as a trade area. The size of the unique trade area for a town within the class depends upon the number of towns in that class. For example, Des Moines is the only town larger than 100,000 population so its trade area is the whole state. There are 13 towns in the next class; hence, the trade area for each is 1/13 of the state. In other words, these trade areas form a series of subsets.

The mean distances to an area trade center of a given size is also plotted in Figure 23. Between the curves based on the above two assumptions are plotted the actual mean distances traveled to various size towns for the purchase of food and furnishing by farm households. The only actual distances lying above the expected upper limit are for towns under 500 population for furnishings and for towns under 200 population for food purchases. This may be because some small towns do not possess establishments supplying furnishings or food.

The positive correlation between town size and mean distance traveled for furnishing purchases supports the findings of the linkage analysis cited earlier. There is little difference in distance traveled to purchase food regardless of town size.

The mean distance traveled for food purchases is not appreciably different for open-country households (Figure 24). However, the distance the householders travel for furnishings does not increase greatly with town size. This may imply, contrary to our assumption

Figure 23. Actual mean distance traveled for a purchase vs. expected[a] mean distance traveled to nested hierarchy of cities, farm household expenditures

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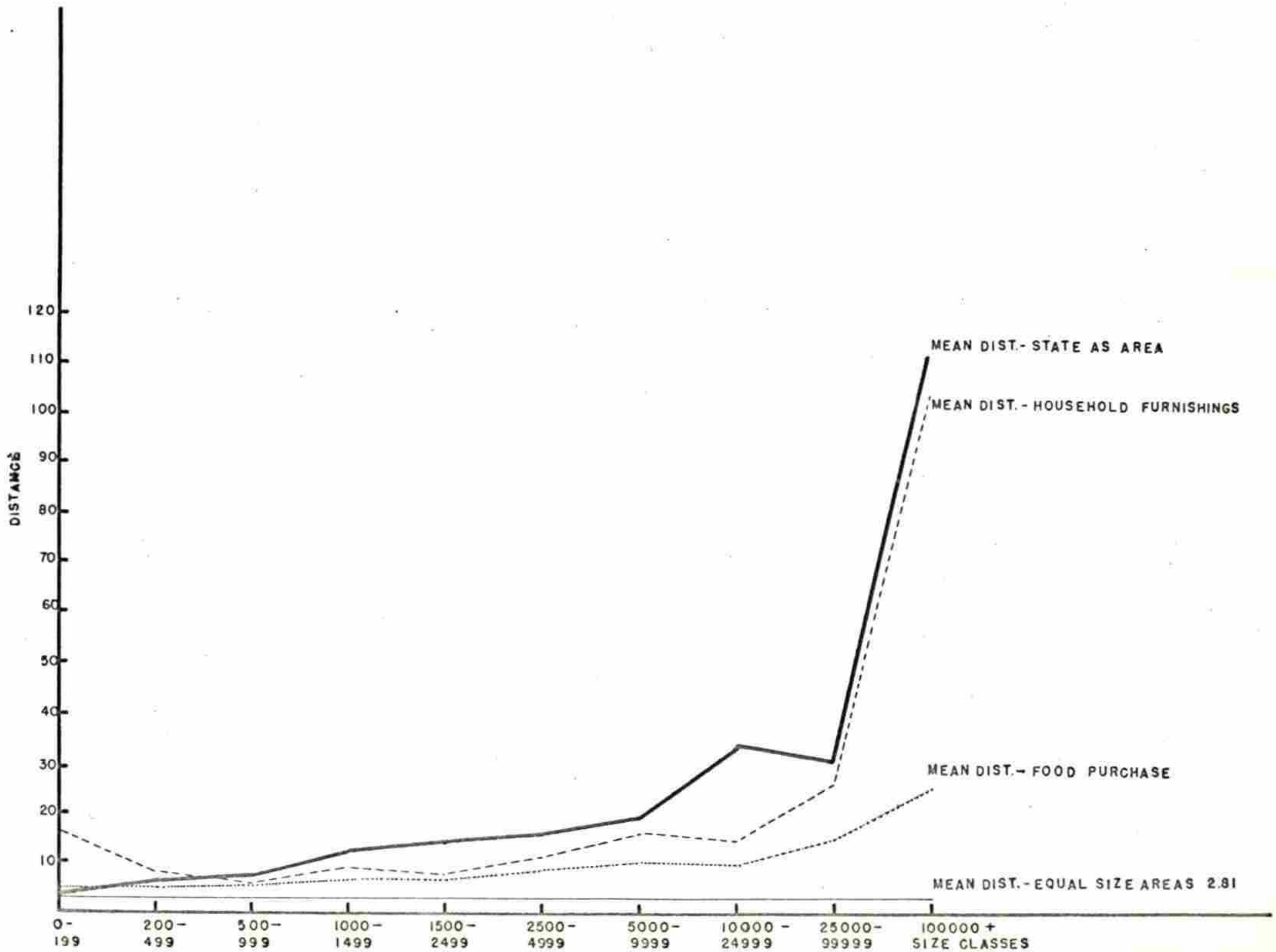
[a]Expected mean distance assumes each trade center size class has the entire state as a trade area (i.e., the size of trade area for a given size center equals the area of the state divided by the number of places in that size class).

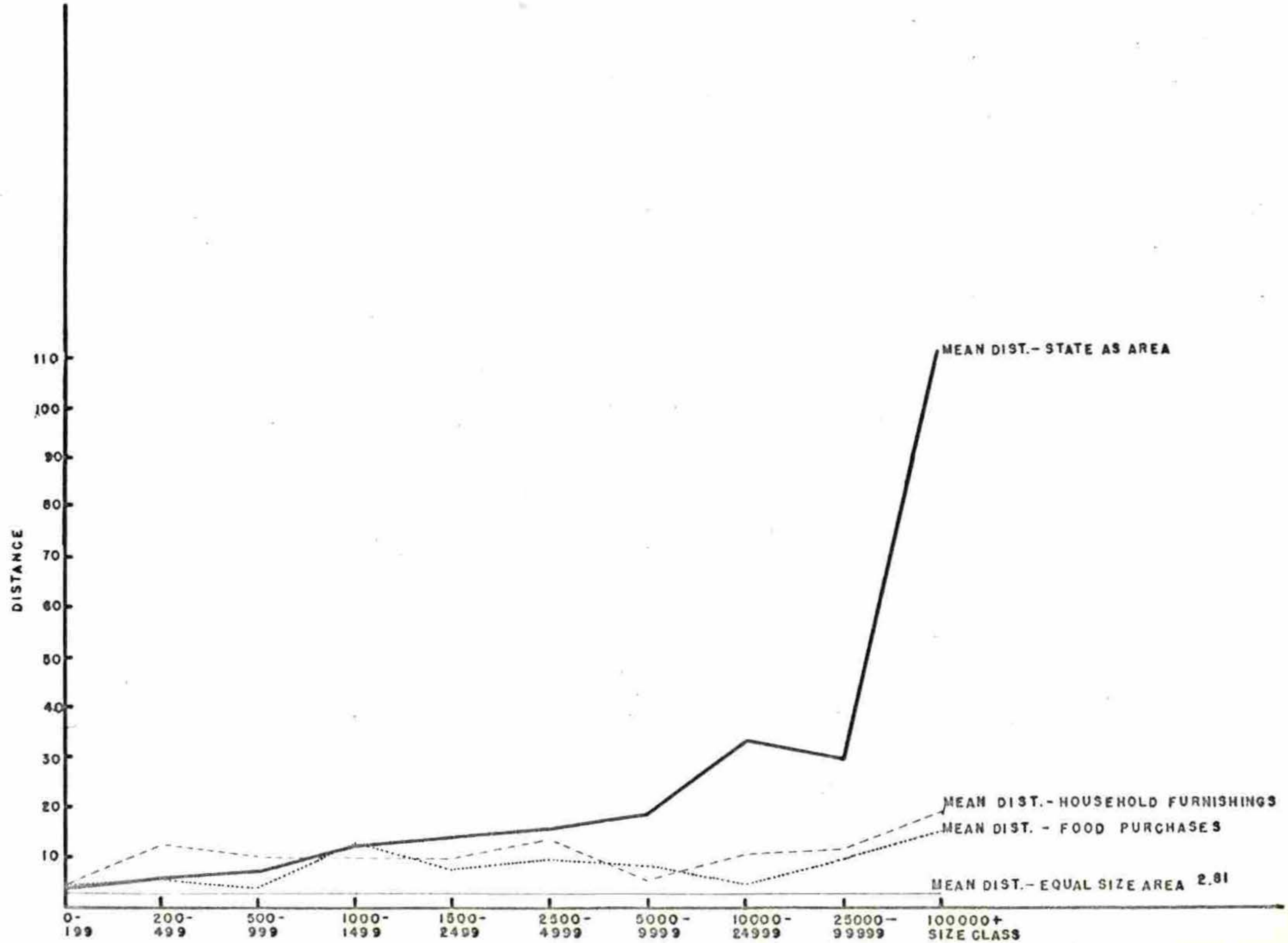


MEAN DIST.- STATE AS AREA
MEAN DIST.- HOUSEHOLD FURNISHINGS
MEAN DIST.- FOOD PURCHASE
MEAN DIST.- EQUAL SIZE AREAS 2.81
DISTANCE
120
110
100
90
80
70
60
50
40
30
20
10
0-199
200-499
500-999
1000-1499
1500-2499
2500-4999
5000-9999
10000-24999
25000-99999
100000+
SIZE CLASSES

Figure 24. Actual mean distance traveled for a purchase vs. expected[a] mean distance traveled to nexted hierarchy of cities, non-farm open-country household expenditures

---

[a]Expected mean distance assumes each trade center size class has the entire state as a trade area (i.e., the size of trade area for a given size center equals the area of the state divided by the number of places in that size class).


MEAN DIST.- STATE AS AREA
MEAN DIST.- HOUSEHOLD FURNISHINGS
MEAN DIST. - FOOD PURCHASES
MEAN DIST.- EQUAL SIZE AREA 2.81
DISTANCE
110
100
90
80
70
60
50
40
30
20
10
0-199
200-499
500-999
1000-1499
1500-2499
2500-4999
5000-9999
10000-24999
25000-99999
100000+
SIZE CLASS

of homogeneous distribution, that most open-country households are located near the larger cities.

Figure 25, which portrays the mean distances traveled for the selected farm purchases, points out a weakness of this technique. We know from our previous analysis that the majority of the expenditures on these two items took place in towns with a population of less than 10,000; therefore, no confidence can be placed on the trends above this town size class because of the inadequacy of the sample size in that range.

The last technique to be applied is a cumulative distance approach in which the basis for comparison is the expected mean distance that must be traveled to reach a town of a given size or larger. As town size increases, the expected base mean distance also increases because the number of such towns is decreasing. Figure 26 shows the actual cumulative mean distances traveled for purchases of food and furnishing by farm households as well as the expected or base mean distances. The location of the cumulative mean distance for furnishings lies above the expectational curve throughout almost its entire distance, implying considerable shopping around for this item. It does not indicate, however, the size town in which travel took place. Nevertheless, it does indicate that the Des Moines trade area does not include the whole state.

The cumulative mean distances appear in Figures 27 and 28 for the selected open-country and farm purchases. This information is essentially the same as for the previous techniques; however, the cumulative nature of the approach disguises some detail, as previously noted.

Figure 25. Actual mean distance traveled for a purchase vs. expected[a] mean distance traveled to nested hierarchy of cities, farm expenditures

[a]Expected mean distance assumes each trade center size class has the entire state as a trade area (i.e., the size of trade area for a given size center equals the area of the state divided by the number of places in that size class).

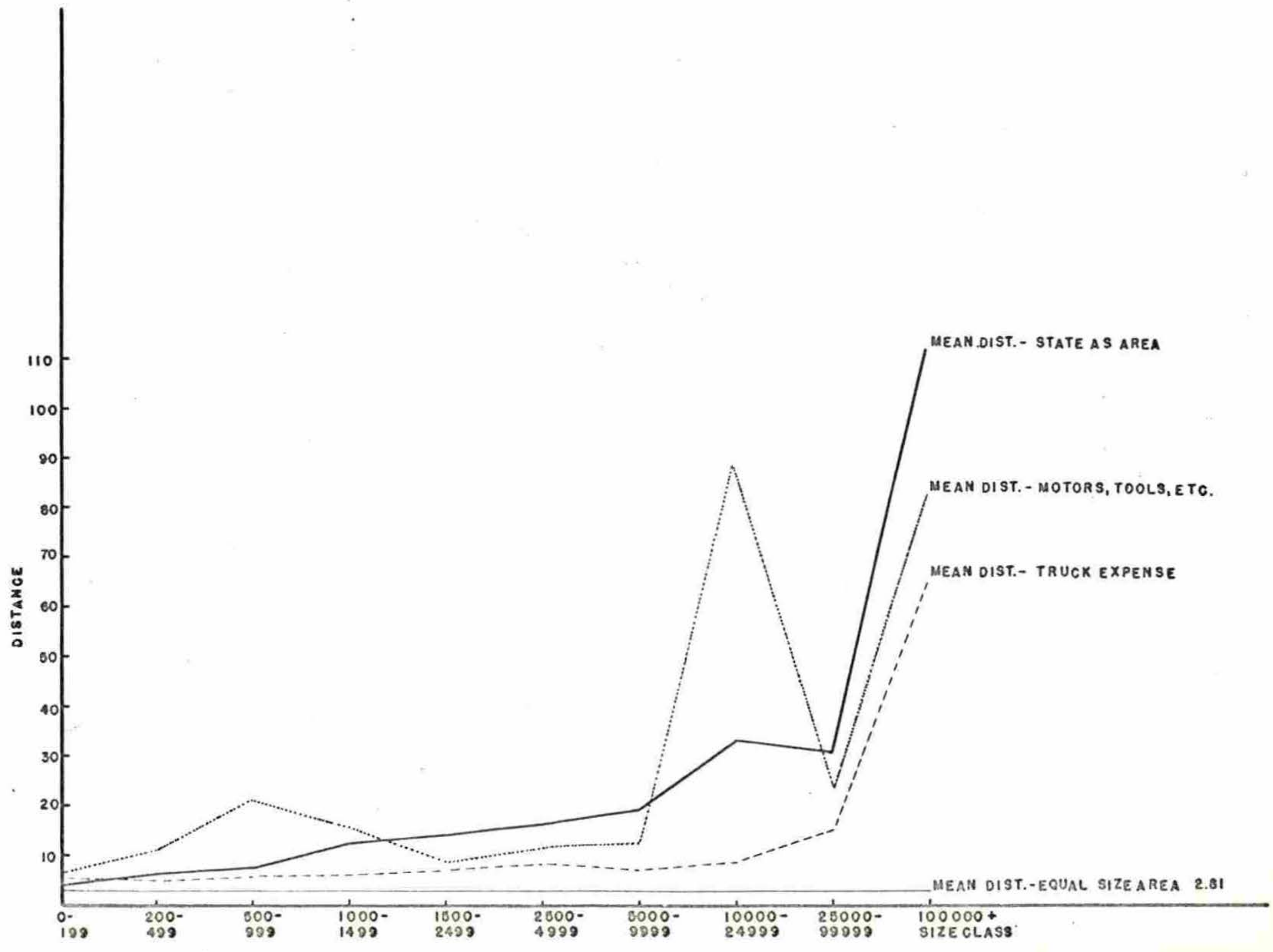

MEAN DIST. - STATE AS AREA
MEAN DIST. - MOTORS, TOOLS, ETC.
MEAN DIST. - TRUCK EXPENSE
MEAN DIST. - EQUAL SIZE AREA 2.81
DISTANCE
110
100
90
80
70
60
50
40
30
20
10
0-199
200-499
500-999
1000-1499
1500-2499
2500-4999
5000-9999
10000-24999
25000-99999
100000+
SIZE CLASS

Figure 26. Actual mean distance traveled for a purchase vs. expected[a] mean distance traveled to a trade center of a given size class or larger, farm household expenditures.

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[a]Expected or base mean distance is calculated by assuming the entire state to be the trade area for given size trade center or larger.

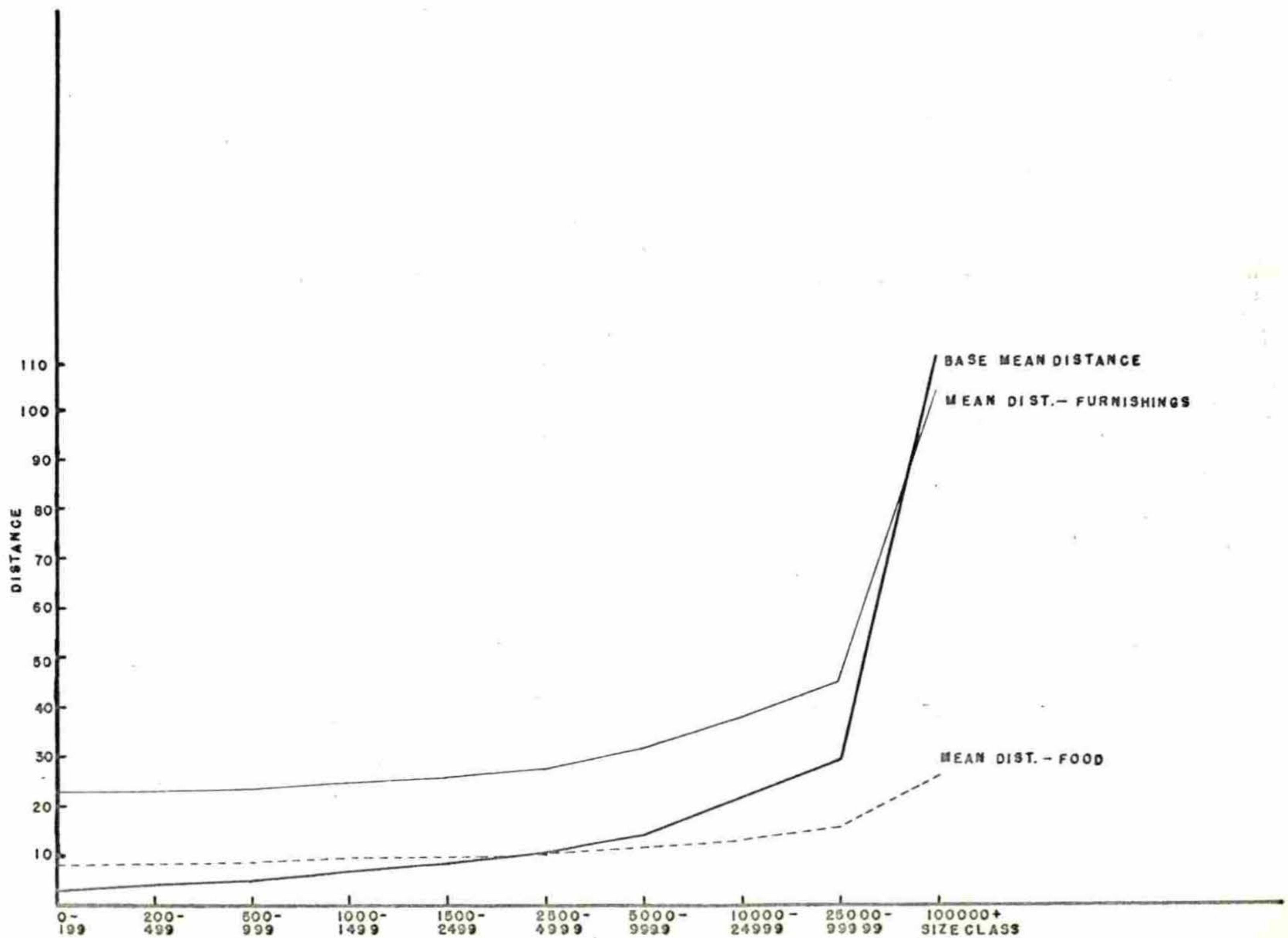

BASE MEAN DISTANCE
MEAN DIST.– FURNISHINGS
MEAN DIST. – FOOD
DISTANCE
110
100
90
80
70
60
50
40
30
20
10
0-199
200-499
500-999
1000-1499
1500-2499
2500-4999
5000-9999
10000-24999
25000-99999
100000+
SIZE CLASS

Figure 27. Actual mean distance traveled for a purchase vs. expected[a] mean distance traveled to a trade center of a given size class or larger, non-farm open-country household expenditures

[a]Expected or base mean distance is calculated by assuming the entire state to be the trade area for given size trade center or larger.

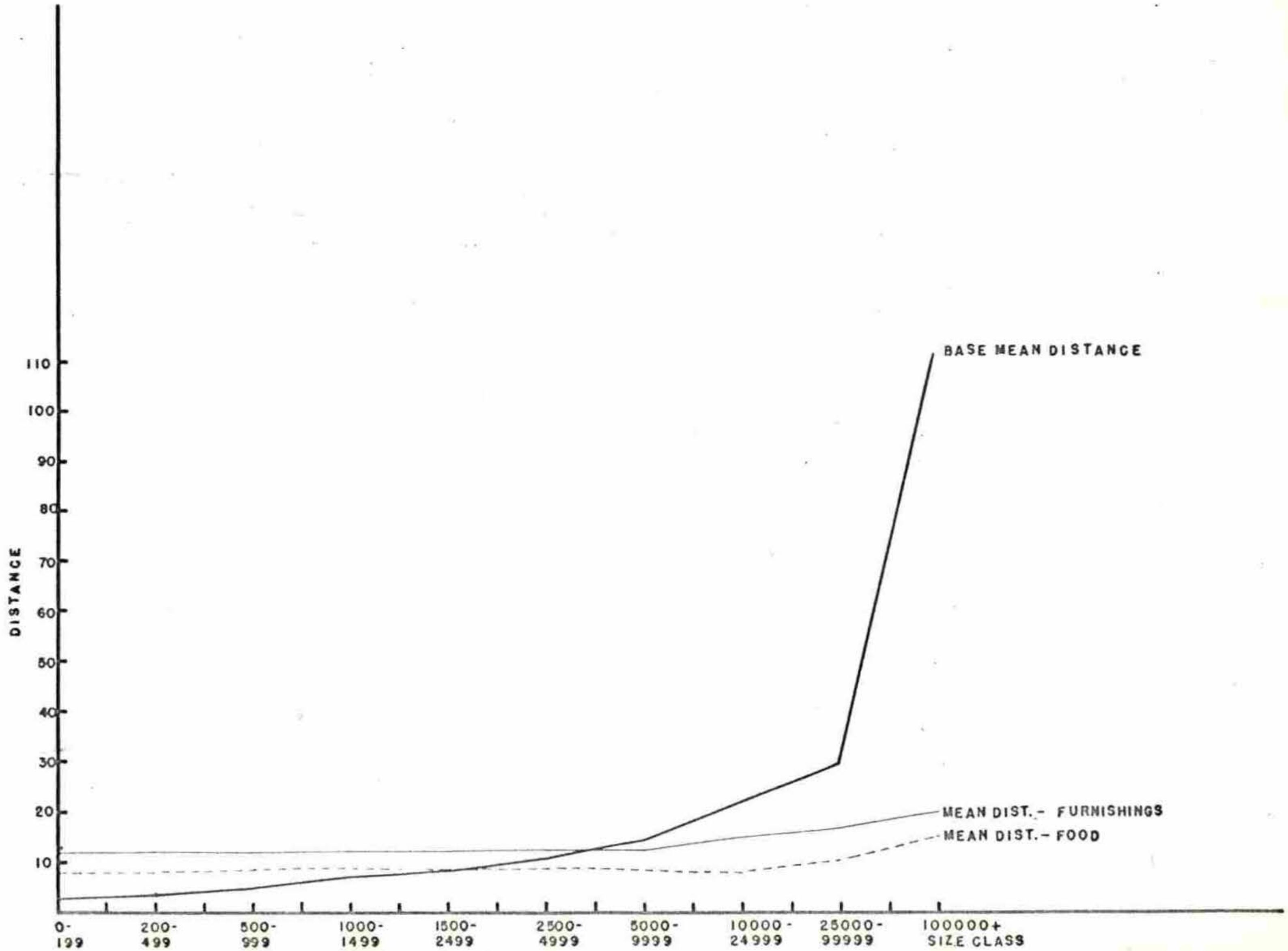
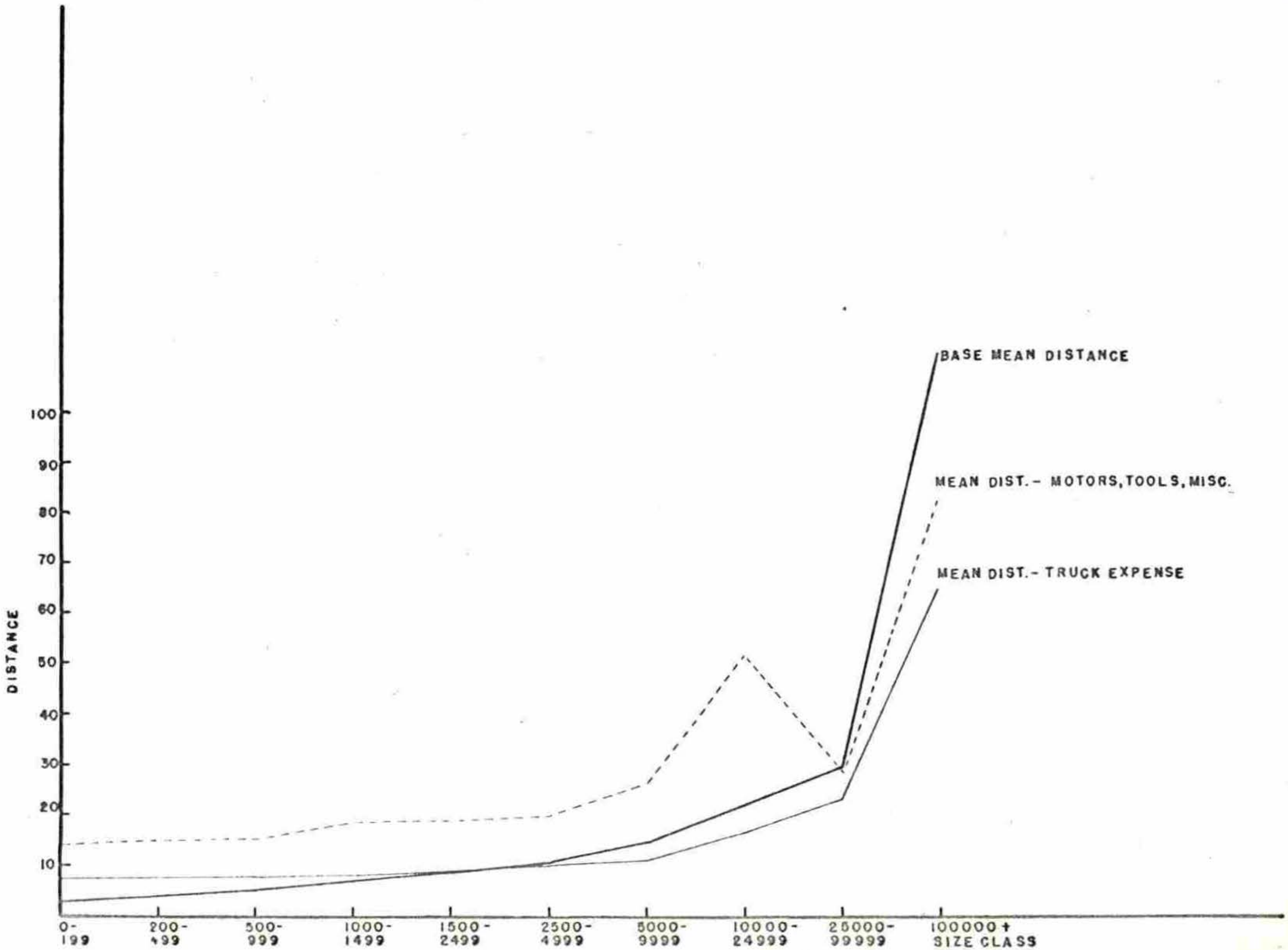

BASE MEAN DISTANCE
MEAN DIST. - FURNISHINGS
MEAN DIST. - FOOD
DISTANCE
110
100
90
80
70
60
50
40
30
20
10
0-199
200-499
500-999
1000-1499
1500-2499
2500-4999
5000-9999
10000-24999
25000-99999
100000+
SIZE CLASS

Figure 28. Actual mean distance traveled for a purchase vs. expected[a] mean distance traveled to a trade center of a given size class or larger, farm expenditures

[a]Expected or base mean distance is calculated by assuming the entire state to be the trade area for given size trade center or larger.


BASE MEAN DISTANCE
MEAN DIST. - MOTORS, TOOLS, MISC.
MEAN DIST. - TRUCK EXPENSE
DISTANCE
100
90
80
70
60
50
40
30
20
10
0-199
200-499
500-999
1000-1499
1500-2499
2500-4999
5000-9999
10000-24999
25000-99999
100000+
SIZE CLASS

One possible use of this technique is for ranking commodities by "order" as was done in the linkage analysis. The "order" of the good would be determined by where the actual cumulative mean distance curve intersected the expected curve.

This chapter concludes the emperical analysis and test of technique. The next three chapters will attempt to assimilate the basic data into a meaningful interpretation of the role of the central cities, the implication for state planning and some tentative conclusions.

VI. THE ROLE OF A CENTRAL CITY IN A REGIONAL ECONOMY

In assessing the role of the central city in a regional economy the most important realization is the diversity which exists among these agglomerations of population that function as central places. This diversity is not only in the magnitude of population but is social and physiological as well. Age and sex distributions vary. Labor force participation rates differ, particularly if a large proportion of the labor force is female. This also suggests differing industrial structures. Though the areas which central places serve may have common elements, such as an agricultural base, they too differ widely in availability and accessability of raw materials and markets. Finally, the central city's function depends heavily on transportation and communication.

A. Hierarchical Systems

One approach to city role determination is Philbrick's (67) hierarchical systems classification of areal economic functions, which was noted in Chapter II. This approach is based on the idea of interrelationship, an idea which has been the central theme of this discussion.

> Individual interconnected areal units of occupance possess two kinds of areal relationship simultaneously. In one case it is the parallel relationship of similar-type units. In the other case it is a series of interconnections between unlike establishments focusing upon the care of a model area of functional organization.
>
> (67, p. 307)

The interrelationship of the "dissimilar" echos the earlier reference to "the chaos which is order". This chaos or dissimilarity can be put in more concrete terms in this context. The dissimalarities to which Philbrick refers are the different functions performed by cities of varying order. In Philbrick's classification a city is identified by the "highest" function it performs. While cities of higher order also perform the functions of places in orders beneath them, it is this additional function which distinguishes them and also, helps to unite the system. The dependence of lower order places upon these higher order functions and the common functions shared by cities of varying order provides the cohesive force.

The Fort Dodge area is an example of a region which contains three orders of places. The household or consuming unit constitutes the first order place. Fort Dodge, the focal center, is a third order place whose highest function is wholesaling. The remainder of the towns in the area perform second order or retailing and service functions. Nine Iowa cities, Sioux City, Council Bluffs, Des Moines, Waterloo, Cedar Rapids, Davenport, Dubuque, Burlington and Mason City are classified as fourth-order places because their functions include transhipment (67, p. 330). All nine serve as focal centers (in the set 15 economic areas presented in Figure 2). One other focal center, Ottumwa, would be classified as third-order. The remaining four focal centers: Creston, Decorah, Spencer and Carroll are second-order places; their function being retailing. The range in the order of the 15 area central cities suggest that their roles differ widely.

B. Competitive Position of Functions

While it has been suggested that regions are composed of hierarchical systems of cities interconnected by dependency and similarity of function, there also exists competition among these towns for the performance of these functions. The results of our empirical analysis reveal this competition both directly and indirectly.

The function most keenly contested is retail selling, a function which all towns perform. Our analysis of consumption patterns suggest three relevant considerations. The first, and most conclusively supported, is that open-country dwellers, both farm and non-farm, tend to drive greater distances, to shop in larger towns, to purchase those items involving greater expenditure. This tendency has a substantial depressing effect upon the net revenue of towns of less than 5,000 population. It further suggests decreasing job opportunities.

The second conclusion suggests that open-country non-farm people make purchases similar to those made by farm household in larger cities than those made by farm people. One possible explanation for this is dispersion (16), the movement of urban dwellers out of the large city, beyond the suburb into the open-country. These people may desire space, peace and quiet, and the type of recreation the open country provides. They are, however, city oriented. They locate within commuting distance of the city. They are accustomed to shopping where the array of goods and services available is complete. The traffic of the city holds less disutility for them than it holds for many farm people. For these reasons open-country households tend to shop in larger towns even though they may be located much closer to smaller places. With the continuing increase of open-country non-farm population this does not paint a very bright business picture for small towns.

The final consideration is much more tentative because it concerns farm purchases, the analysis of which was limited. The results suggest, however, that farmers make many of their purchases in smaller towns, say under 10,000 population. This is consistent with the types of establishments found in small towns (75, 78). As previously noted one of the main functions of small towns is the servicing and maintanance of motor vehicles. Even if farmers continue to patronize smaller towns, the continuing decline in the number of farms and farmers does not indicate that these towns will grow or improve their competitive position. The future role of small towns will be primarily as "convenience" centers.

Competition for industry and labor are closely related to "functional" competition. The effects of this competition are reflected in commuting patterns and population movement.

Both the Upper Midwest and the Northern Plains studies discussed in Chapter V indicate that most commutation is directed toward the larger, thriving urban area. "Labor market areas are defined by the level of prosperity or lack of prosperity in nearby central cities as well as by the physical facts and distance. The economic strength or weakness of labor supply areas is a major factor influencing their degree of dependency on the central area (37, p. 130). In competing for the labor, smaller towns usually have a distinct disadvantage because they cannot provide attractive job opportunities. Industry chooses to locate in already prosperous areas. It is a case of growth breeding growth.

In the Fort Dodge area we have seen a region for which this generalization is not true. Fort Dodge does not attract a proportionately greater number of commutors than other smaller cities and towns located in other counties in the area. It is also noted that while the other studies showed that migration to growing urban areas is the rule, Fort Dodge showed an increasing net out-migration from 1940 to 1960. This raises some serious questions concerning the role Fort Dodge is or should be performing as a regional center. This out-migration of young employable adults from the city and from the region is a serious loss of capital. Tarver (77) estimates, that, in 1954 dollars, it costs $15,000 to rear and educate a farm child to the age of 18 years. A similar figure surely applied to the youth of cities and towns. Adequate employment in the central city would be a major step in stemming this devastating outward flow of capital and productive potential.

The movements in population to area focal centers noted in Chapter III, may be regarded both as a cause and an effect of the competitive advantage being enjoyed by larger cities. It is a cause from the standpoint that most purchases made by people living in a city take place in that city. Consumption requires production and production requires labor. On the other hand, the attraction of an increased labor force means increased population, hence, population increase occurs as the result of competitive growth and development. The population of any area or city is closely associated with the possibilities for making a living there.

Since the shift in employment and population in most cases is toward the central city, the shift of employment among industries has implications for the city's role. In fact, even though there is not a dramatic employment shift to the central city, interindustry employment relationships play an important part in determining the cities future. In the case of the Fort Dodge area, for example, the results of the analysis in Chapter IV provides some suggestions for development policy. In the first place, the basic-service ratio is declining. "Failure to expand the basic sector results in restricted growth of central places (68, p. 9)". As was noted in Chapter I, virtually nothing can be done to increase employment in agriculture, the major industry in the basic sector. Employment in wholesale trade is declining and growth in retail trade employment is below the rate of total national employment growth. There are, however, two promising basic industries within the major industrial heading manufacturing. They are food and kindred products which showed an employment growth rate of 76 percent between 1950 and 1960 and other durable goods which grew 43 percent during the same period. While manufacturing as a whole did not classify as a basic industry, it, along with three other major service industries--public administration, finance, insurance and real estate, and services--showed an employment growth rate greater than the national rate. The results correspond almost exactly to the findings of the Northern Plains study (28). These three service industries, together with the previously mentioned basic industries, offer the greatest opportunity for stimulating the growth and development of the region. Because of the concentration of these types of industries in urban areas, the indication is particularly meaningful for Fort Dodge. Looking briefly at the relationship of two of these "service" industries in light of recent development trends Lampard says, "the principle function of the city today is in terms of the employment it creates in the provision of services rather than manufacturing (47, p. 341).

C. Optimal Spatial Systems

This raises a question concerning city role. What is the relationship of service functions versus convenience functions? Some plausible suggestions in this regard are made by Hodge (41). He classifies Saskatchewan towns with respect to convenience versus retail services according to the number of establishments located in the town. Because of the high correlation between town size and number of establishments located in the town, the population classification used in our study will serve as an approximation ranking.

The following hypothesis which we have tested is based on one suggested by Hodge. In the type of area we have been considering the number of towns at both extremes of the retail service increases over time relative to towns in the middle range of the hierarchy (41, p. 10). In other words, those very small towns, say under 200 population with a minimum of establishments providing primarily low order goods and those larger towns, say above 5,000 population, providing a greater selection of higher order goods are increasing in number, while the number of towns in the middle, too large to be considered simple convenience centers and too small to possess the necessary range of higher order goods is decreasing.

If we compare the change in the number of incorporated Iowa towns in these three size classes from 1950 to 1975, we find that this is in fact exactly what is happening. The results of this comparison appear in Table 26.

What accounts for this type of change in town distribution? One possible explanation is that towns of less than 5,000 population located in agricultural areas are basically "retirement centers" for the surrounding farm population. Their principle function is supplying goods and services to these people and the surrounding farms. As mortality takes its toll within the towns and the farm population declines, fewer people exist to repopulate these towns and the area demand for the function of the town also declines. Hence, many of these places have shrunk or are shrinking to mere convenience centers of less than 200 population with a few establishments supplying the necessities of daily life, a grain elevator, and perhaps a machine dealer. A few of these towns, strategically located, have acquired some form of industry and have grown into the next size class.

The results of the consumption pattern analysis also support this explanation. The purchase of higher order goods takes place in larger cities further clarifying the long run function of focal centers.

Table 26. Change in number of small, medium and large incorporated Iowa towns, 1950-1975

Item	0 to 199	200 to 4,999	5,000 and up
1950	182	701	51
Change	+16	-13	+7
1960	198	688	58
Change	+18	-15	+11
1975	216	673	69
Total change	+34	-28	+18

VII. IMPLICATIONS OF AREA PROJECTIONS FOR STATE DEVELOPMENT PLANNING

Before concluding our discussion, we look briefly at some of the implications of an areal approach and the role of the central city for state development planning.

A. Development Strategies

The principle determinant of development strategy on any level is that elusive and sometimes nebulous concept known as a goal. Goals present a particular problem for state development planning because of the conflicts that arise. There are conflicts among economic, political and social goals. Even more perplexing are the conflicts among regions, among cities, between regional and state goals and between city and state goals.

The most common word in the language of economics is "optimum". However, what is optimum depends upon one's point of view. What is optimum for the state, for example, may not be optimum for the region. Leven (48) suggests at least three reasons for this conflict. First, the preference patterns of regions may be such that, where there are multi-dimensional economic goals, there will not be a consistent ordering of these goals at the national level. Second, each region's share in re-location costs needed to achieve a goal of maximum output may not be equal to their share in the resultant gains. Finally, external economies or diseconomies in production extending across regional boundaries have not been considered in either of the other reasons. No matter what goals are selected all will not benefit equally.

A goal frequently adhered to by development planners is to increase the overall employment base. This is the objective of the Appalachia program (80). Once a goal has been selected it is then necessary to choose a comprehensive development policy composed of goal seeking activities. The Appalachia planners have chosen an approach which will serve as an illustrative example for this study. Indeed, this approach also offers a great deal of promise for wider use in the type of regions we have been discussing.

The Appalachia plan consists of a dual emphasis. This emphasis is on cities currently showing the greatest growth potential and on highway systems. The object is to move the labor force to cities where jobs are available rather than attempting to create jobs in the depressed areas where the excess labor supply exists. Development funds are poured into counties and cities currently showing growth and into two types of roads. Local access highways are constructed to enable people to get out of previously inaccessible valleys. Development highways are being built to link core cities in the area and the outside (42, p. 27).

While this approach definitely dooms some geographic areas to further depression it enables the people living in these areas to escape. More important, it provides a very concrete definition concerning the role of central cities.

B. Information Requirements

Before a state can adopt and implement a development program, such as the Appalachia plan or any other, a considerable amount of data is required concerning job opportunities, labor supplies, raw material supplies, and market demand. It is necessary to know not only the number of jobs available, but the location and nature of the jobs as well as which industries show the greatest potential demand for labor. The composition of the labor force is equally important. The age and sex of the population, the labor force participation of persons over 14 years of age by sex, the education of workers and their industry and occupation all influence development strategy.

The availability and accessibility of raw materials and market demand help determine plant location and investment. Market demand may be assessed on the basis of household composition, median income and distribution, and age structure of the population.

Many of the data needs can be fulfilled from analysis based on data from the U.S. Census while other information, such as raw material supplies, must be secured from surveys and field work.

C. Development Planning Areas

The question of areal delineation of regions has been discussed in Chapters II and III from the standpoint of economic criteria. A much knottier problem, however, are the political criteria for area delineation. The implementation of any development project is dependent upon the organization and supervision provided by a unified planning body. If the area under consideration is a single state or a single county, then the political criteria of state government or county government corresponds to the economic delineation. But, if the region delineated by economic criteria involves a multi-county area or, even worse, if regional boundaries intersect counties as do Fox's (30) diamond-shaped regions, than no unified governmental body exists. In the case of divided counties, the necessary data also are non-existent.

Few economists or regional scientists will argue the merits of the archaic county concept. Yet, chances are very slim that the archaic county boundaries will quietly "wither away". One possible approach for the state planner, at least for the present, is to attempt to enlist the cooperation of the counties involved in a given regional delineation much as states are cooperating in the Appalachia program. In the case of sub-county involvement it may be necessary to resort to field work to obtain necessary data.

In 1950 Francois Perroux (66) suggested three definitions of economic space which might be used for area delineation, planning, fields of force, and homogeneous aggregation. The areas delineated by these techniques are not of the usual contiguous geographic nature. Perroux explains these concepts in terms of the economic space of a firm or firms. A space defined by a plan would be composed of those areas effected by the planned operation of a firm. It would include the plant location, market areas, areas of raw material procurement, etc. A space defined by fields of force consists of any areas falling under influence of the firm, planned or unplanned. Finally, homogeneous aggregation defines a space, for example, of firms which belong to the same price regime. Their everyday conditions of cost, production, and location may differ, but the price at which they offer their products to the consumers of various areas are roughly the same.

These definitions might be applied in the context of a city rather than a firm. Envision, for example, a region defined by all the plans originating in a given city, both public and private. Or, in the case of a space defined by fields of force a region would include those areas influenced in any way by the functioning of the city. The concept of a regional delineation based on homogeneous aggregation might be thought of in terms a system of cities of similar functional order.

While these types of regional delineation possess considerable theoretical appeal, any attempt at empirical application would meet with the same problems of supervision and data we have been discussing.

D. The Role of Economic Projections

Development planning is concerned with the economic activity of the future. Such planning may be based on past development and current status, but the success of any program is largely dependent upon the projection of future trends. As in the case of the firm, the more complete the knowledge available the closer production is to optimum. So, in the case of development strategy, the more accurate future projections, the greater the success in the attaining of development goals. Reliance on cardinal projections always requires careful recognition of the possibility of unforeseen sharp fluctuation in economic activity; however, even reliable ordinal relationships regarding future activity are extremely useful.

One possible approach to state development planning is an area by area analysis similar to the one conducted for the Fort Dodge region. This enables a comparison of the economic health of various regions. No region, of course, is an individual entity; therefore, knowledge of the relationships of economic activity both within and between regions is necessary.

Assuming that the Appalachia approach is an applicable approach to state development planning, what does the type of information regarding population, employment and consumption we have generated suggest in terms of policy? First, population movements indicate to the planned the viability of regions and cities. This serves as a guide for investment, both public and private, in those areas showing the greatest growth potential as defined by population concentration.

For example, the Markov projections for the size distribution of incorporated Iowa towns suggest an increase in the number of large and small towns. Combining this information with population projections we find fewer people living in more small towns while the bulk of the population is concentrated in the relatively large cities. Migration data for the Fort Dodge area indicate that this area may be an exception to this trend, thus indicating the need for a different planning approach for this area than, say, for the Des Moines area.

Shifts in employment provide two types of information. Shifts among industries, as determined by economic base and shift analysis provide additional criteria for the efficient allocation of investment in "growth" industries; for example, industries with a positive net relative shifts. Commuting patterns furnish the state planner with information regarding the need for and location of new highways and the widening and resurfacing of old ones. These highways facilitate movement of the area labor supply to the centers of economic activity.

The Fort Dodge area analysis indicated four industries: manufacturing; financing, insurance and real estate; services; and public administration, which have a positive net relative shift. Examination of area commuting patterns, however, did not show any distinct concentration on Fort Dodge. This may suggest a need for investment to stimulate these industries in the city, a need for improved access routes to the city or both.

The study of consumption patterns supplies much the same type of data as the study of employment patterns. They indicate to planners and investors the types of goods and services demanded by open-country residence in the central city. This demand can be increased by highway systems which make the city more accessible.

Accurate area projections, an awareness of interregional relationships, and a knowledge of the function of the central city are essential to efficient state development planning.

VIII. SUMMARY AND CONCLUSIONS

The elements of research strategy identified, employed, and evaluated in this thesis have been those techniques adaptable to a population systems approach to the analysis of economic activity. The assumption underlying this approach is that changes in population and employment are useful indicators of economic growth and development. The analytical system employed involved no particularly sophisticated techniques.

Total population projection were derived using the Hamilton-Perry technique. The temporal movement of incorporated population among towns was analyzed using a simple Markov procedure which was found to give more accurate results than the elaborate rank-size rule. Shifts and projections of employment were derived using an economic base and a shift analysis approach. Spatial mobility was studied graphically and with the use of a natural increase-type migration model. A graphic technique was also employed to study consumption patterns.

The information generated by these techniques suggest the following relationships and trends:

(1) A shift of population and employment to larger cities showing growth potential;

(2) Failure of the central city to provide adequate job opportunities results in dispersed commuting patterns and loss of human capital from the area;

(3) A tendency for farm and open-country households to travel to larger cities to purchase consumer items involving greater expenditure;

(4) As a result of this and the decline in farm population the number of towns with a population of 200 to 5,000 is declining while the number of smaller and larger towns is increasing;

(5) The most promising industries for stimulating development and maintaining growth in the central city are manufacturing, services, public administration and finance, insurance and real estate.

We may speculate on the demand and supply elasticities for the industries listed under the last point. These industries may be old established industries with a demand elasticity greater than one or they may be new industries whose demand elasticity need not be greater than one. It is probable that the supply elasticity is greater than one for both types of industries. One of the problems of Fort Dodge may be that its industry mix contains too many industries whose demand elasticity is less than one.

With reference to shift analysis, industrial mix effect may be caused by demand elasticity, while the regional share effect reflects supply elasticity. The reasons for this are: (1) industrial mix shows growth relationship of a given industry's employment with reference to the nation thus reflecting the propensity to consume the industry's product, and (2) regional share effect shows the relationship between employment growth for a given industry in the region and in the nation thus reflecting that industry's supply.

What final conclusions or, perhaps more correctly, hypotheses can be made about central cities in regional development? The finding we have outlined shows that the central city has played an increasingly dominant economic role within the region. More and more is being expected of it in terms of employment opportunities and goods and services demanded. Perhaps an Appalachia-type approach most realistically recognizes the role of the central city in long-run area growth. The central city has proved to be the center of area economix health. Employment opportunities tend to concentrate in these cities. The goal is to further accelerate the growth of this employment. This can be done by concentrating investment in those industries identified by economic base and shift analysis as possessing the greatest growth potential. The final step is the provision of an adequate highway system to enable easy access to the focal center from any point in the area.

Much of the accumulation of economic surplus necessary for investment, growth, and development is concentrated in the city. In this sense, these urban places shape and determine the future of the present space economy.

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